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Factors Impacting Mortality in the Pre-Hospital Period After Road Traffic Accidents in Urban India

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Abstract

Background: India currently has the dubious distinction of experiencing the highest number of road traffic accidents in the world.
Objectives: We believe that this study on road traffic accidents may help to identify factors in the pre-hospital setting that may influence mortality rates.
Patients and Methods: A prospective observational study was carried out in a metro area in India over a period of one year. The study included consecutive patients admitted to the trauma service after road traffic accidents. Demographic information, time and place of accident, and details regarding the vehicle and the events leading up to the hospital admission were recorded. Injury severity, management in the hospital, and final outcomes in terms of mortality were noted. The data were analyzed with SPSS software.
Results: A total of 773 patients were enrolled. Of these, there were 197 deaths and 576 survivors. The majority of patients were aged 15 - 40 years (67%) and were male (87.84%). More accidents occurred at night (58.2%) than during the day (41.8%). Mortality was not significantly associated with age, sex, or time of accident. City roads (38.9%) saw more accidents than highways (26.13%), but highway accidents were more likely to be fatal. Two-wheeler riders (37.65%) and pedestrians (35.75%) formed the majority of our study population. Mortality was significantly associated with crossing the road on foot (P = 0.004). Pillion riders on two-wheeler vehicles were more likely to experience poor outcomes (relative risk [RR] = 1.9, P = 0.001). Front-seat occupants in four-wheeler vehicles were at an increased risk of not surviving the accident (61.98%; RR=2.56, P = 0.01). Lack of safety gear, such as helmets, seat belts, and airbags, was significantly associated with mortality (P = 0.05). Delays in transfers of patients to the hospital and a lack of pre-hospital emergency services was significantly associated with increased mortality (P = 0.000).
Conclusions: A lack of respect for the law, weak legislation and law enforcement, disregard for personal safety, and driving vehicles under adverse conditions are some of the leading causes of road traffic accidents. There should be an emphasis on emergency trauma care in the pre-hospital setting.

Keywords: Road Traffic Accidents, Mortality, India, Pre-Hospital Events

1. Background

An accident is defined as "an unfortunate incident that happens unexpectedly and unintentionally, typically resulting in damage or injury" (1). Accidents occurring on the road, involving pedestrians and/or vehicles, are termed road traffic accidents (RTAs). Over the last century, an emphasis on infrastructure has led to increased numbers of roads being built in India. Unfortunately, this has been accompanied by a rise in the number of RTAs. The world health organization (WHO) global status report on road safety 2013 showed that India has the dubious distinction of reporting the largest number of deaths due to RTAs in the world.

We work at one of the largest urban tertiary care trauma centers in western India. Over the years, we have observed a steady rise in the number of casualties due to RTAs, and patients' outcomes are often impacted by their pre-hospital course. Factors related to the patient (such as demographic profile), the road, and the vehicle affect the victims' outcomes. Identifying these factors will help in the planning of strategies to reduce the burden of RTAs.

2. Objectives

This study was carried out to learn about the epidemiologic profile of RTAs, with a special focus on the pre-hospital setting. We believe that our study is fairly representative of the urban setting in India and probably of the developing world.

3. Patients and Methods

We carried out a prospective observational study over one year, from June 2008 to May 2009, in a tertiary care trauma center in Mumbai, India. Clearance of the institutional ethics committee was obtained prior to commencement of the study. Written informed consent was taken from each patient prior to enrollment in the study. Consecutive patients admitted to the trauma service after RTAs were enrolled. The data were collected using a standard proforma, via interviews with the patients (if conscious and oriented), friends, relatives, policemen, or bystanders, if available. A detailed clinical examination (following the advanced trauma life support guidelines) was performed on each patient by the same surgical team. The demographic data were recorded, as well as details of the RTA, such as the time of the incident, location, type of vehicle, position of the victim in the vehicle, mechanism of injury, and availability and impact of safety gear. The availability of qualified medical or paramedical personnel or on-site resuscitation was noted, and alcohol intoxication of the patients was recorded. Injury grades and severity scoring were assigned using the injury severity score (ISS). Events during the hospital stay, and the final outcome in terms of mortality and morbidity, were recorded. Deaths occurring after discharge from the hospital were not included in our analysis. We did not perform extended follow-up in our study.

RTAs were defined as accidents occurring on the road (including sidewalks or footpaths), involving a vehicle and its occupants and/or pedestrians. The mechanisms of injuries in persons involved in RTAs with four-wheeler vehicles were classified as deceleration, lateral impact, or ejection injuries. RTAs involving stationary vehicles on the road, falls off of overhead bridges, etc., were classified as "other". Pedestrian injury was classified as injury due to impact of a vehicle while crossing the road or by the roadside. Safety gear included helmets, seat belts, and airbags. Evidence of alcohol consumption was determined by testing blood alcohol levels after admission; levels of 0.03% or 30 μg/dL and above were considered evidence of intoxication. Traffic-rule violations that may have led to the accident were recorded from the police data. The pre-hospital interval was the time period between the accident and the patient's arrival at our center. Availability of emergency services was considered the presence of an ambulance with accompanying medical or paramedical personnel. Polytrauma was defined as two or more injuries to physical regions or organ systems, one of which may be life threatening, or an ISS of > 15. Operative management included all surgical interventions, such as tube thoracostomy, exploratory laparotomy, craniotomy, and thoracotomy. The data were entered into Microsoft Office Excel and analyzed using SPSS version 16. Appropriate tests of significance were used for comparisons, and a $P < 0.05$ was considered significant.

4. Results

A total of 1,430 patients were admitted to our trauma service over the study's duration, including 856 victims of RTAs. Forty-five patients asked for transfer to a private hospital and 38 patients refused to participate, and the remaining 773 were enrolled and analyzed. Of these, 197 patients died and 576 survived their accidents. The age distribution of patients in the study is shown in Figure 1; 518 (67%) were 15 - 40 years old. There was no significant association between mortality and age (P = 0.57). The study included 679 males and 94 females, and mortality was observed in 179 males and 18 females. The association between gender and mortality did not reach statistical significance (relative risk [RR] = 1.37, P = 0.17.

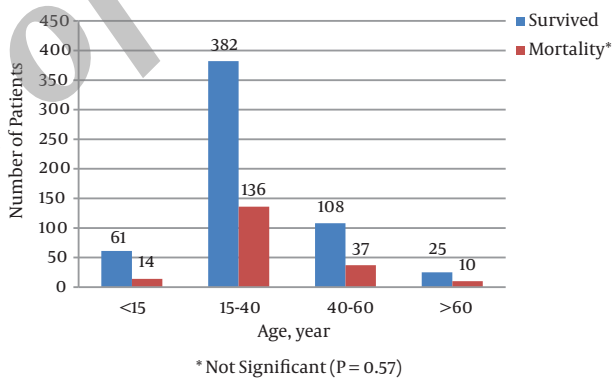

Figure 1. Age Distribution

We observed that 450 patients (58.2%) had accidents between 7 p.m. and 7 a.m., while the remaining 323 (41.8%) had accidents between 7 a.m. and 7 p.m. The time of accident was not significantly related to mortality. Of the 301 (38.94%) patients whose accidents were within the city, 226 (75.08%) survived and 75 (24.92%) expired. RTAs on highways were responsible for 202 (26.13%) patients coming to the hospital, of which 143 (70.79%) survived and 59 (29.21%) expired. Of the 270 (34.93%) patients whose accidents occurred beyond the city limits, 207 (76.67%) survived and 63 (23.33%) expired. There was no significant association between place of accident and mortality (P = 0.34). We observed that 396 patients out of the 481 who had accidents within 10 km of the city survived, while 85 expired. Of the 292 patients who had accidents >10 km from the trauma

center, 112 expired and 180 survived. An accident location of > 10 km from the trauma center was significantly associated with mortality (P = 0.001). Details about the types of vehicle involved or pedestrian involvement in the accidents are shown in Figure 2. There were 291 pedestrian RTA victims in this study; 216 were struck while crossing the road and 75 were struck while on sidewalks or footpaths. Of the 81 pedestrian mortalities, 70 belonged to the former group while 11 belonged to the latter. There was a significant association between mortality and being struck while crossing the road (P = 0.004).

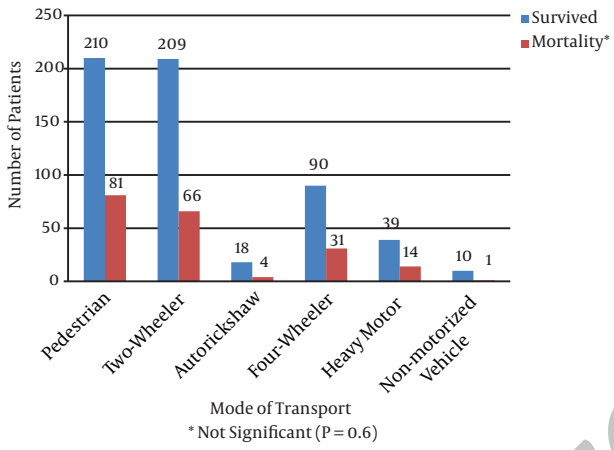

Figure 2. Mode of Accident

Two hundred seventy-five patients were riding motorized two-wheelers when their accident occurred; 108 were riding alone, while the remainder involved two or more persons on the vehicle. Sixty-six (24%) of the patients in this group expired. Pillion riders suffered a higher mortality rate than individuals operating the vehicle (17.92% vs. 34.31%, RR = 1.9, P = 0.001). Only two of those who expired were wearing a helmet while riding. Out of the 209 survivors, 159 were wearing a helmet at the time of the accident. The failure to wear safety gear was significantly associated with mortality (P = 0.00).

Twenty-two patients in this study had accidents involving auto-rickshaws, including 18 survivors and four fatalities, which included two auto-rickshaw drivers and two passengers. The position of the victim in the vehicle was not significantly associated with mortality. An additional 121 persons had RTAs while travelling in four-wheelers; of these, 75 were front-seat occupants and 46 occupied the rear seats. Our analysis revealed that the front-seat occupants were more likely to succumb to their injuries than the rear-seat occupants (33.33% vs. 13.04%, RR = 2.56, P = 0.01). The mechanisms of injury in RTAs involving four-wheeler vehicles were categorized as deceleration (33.88%), lateral impact (35.53%), ejection (23.97%), and other (6.62%). We did not observe an association between the mechanism of injury and mortality (P = 0.28). Thirty-six patients involved in four-wheeler RTAs reported the use of safety gear. Only five deaths occurred when safety gear was used in the vehicle, whereas there were 26 deaths when no safety gear was used. Thus, there was a statistically significant association between safety gear and mortality (P = 0.05). In RTAs involving heavy motorized and non-motorized vehicles, mortality was not significantly associated with the position of the person in the vehicle. Safety gear was either not used or was not available in these accidents.

Evidence of alcohol intoxication was found in 204 patients, and mortality in this group was 29.4%. Alcohol consumption was not significantly associated with increased mortality (P = 0.13). Traffic-rule violations were reported in the accidents of 589 patients, while for the remaining 184 patients, either there were no violations (n = 158) or details were not available (n = 26). Mortality when traffic rules were violated (26.48%) was not significantly higher than when they were obeyed (22.28%, P = 0.25).

The time taken for RTA victims to be transported to our facility is shown in Figure 3. Delays of more than 24 hours were significantly associated with increased mortality (P = 0.00). Pre-hospital emergency services were available to bring 130 victims to the hospital, while 643 were transported from the accident site by means other than ambulances and by non-qualified personnel. The former group included 12 deaths and the latter included 185 deaths. There was a statistically significant association between unavailability of emergency services and death (P = 0.00).

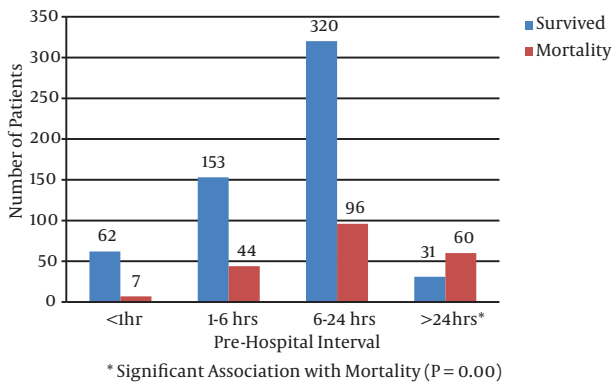

Figure 3. Pre-Hospital Intervals of RTA Victims

The observed injury patterns are shown in Figure 4. Major trauma or polytrauma (ISS > 15) was observed in 417 pa-

tients. This group had a higher mortality rate than those with an ISS of $\leq$ 15 (36.2% vs. 12.9%, P = 0.00). Ninety-six deaths occurred within 24 hours of admission to the hospital, an additional 54 occurred 24 - 96 hours after admission, and the remaining 47 occurred after 96 hours. Two hundred thirteen patients required surgical management, while 560 were managed with non-surgical therapies. Surgical management was unable to salvage 93 patients, and 104 patients who expired did not receive surgical treatment. Of the 576 patients who survived, 65 lost one or more extremities, resulting in permanent disability, and 46 were unable to care for themselves as a result of severe head injuries.

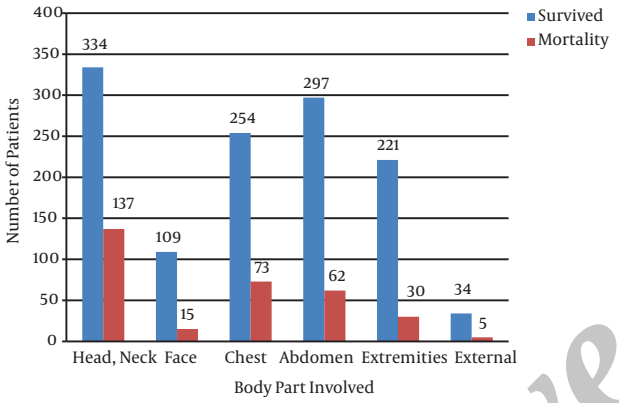

Figure 4. Injury Patterns

5. Discussion

Mortality after RTA has traditionally been described as early or delayed. Early mortality occurs at the site of the accident, as injuries can cause death almost instantaneously. Among those who survive an RTA, delayed mortality may be observed. Urgent and appropriate medical attention helps to save the lives of these victims. In RTAs, prevention is certainly better than cure, and we believe that the pre-hospital setting has an impact on the outcome.

In our study, individuals aged 15 - 40 years were involved in the majority of the RTAs (67.01%), and this group also had the highest mortality rate. From India, Rastogi et al. (2), and internationally, Wui et al. (3) have shown that this age group is not only more commonly involved in accidents but also experiences the highest mortality rate. This age group is more often involved in vehicular crashes, while the older age groups usually suffer from pedestrian injuries in RTAs (4). The majority of our study population was male (87.8%), and other studies have demonstrated a higher mortality in males (5). There are several explanations for this observation; for example, more males than females take to the road, and males are more likely to engage in risky behavior, such as substance abuse and driving a vehicle irresponsibly.

Fewer accidents were noted during the daytime. Although mortality was higher in nighttime RTAs, we did not observe a significant association between death and time of accident. Mishra et al. (6) have also demonstrated that fatal RTAs are more likely to occur at night. This is probably due to nighttime being associated with empty roads, a temptation to speed, decreased driver awareness, substance abuse, fatigue, and poor street lighting. An implication of this finding is that emergency response services need to be available around the clock.

More RTAs occurred on city roads than on highways in our study, but the highest mortality rate (41.26%) was observed in the highway accidents. Data presented to the parliament of India by the ministry of road and transport in 2008 suggested that more than half of fatal RTAs in India take place on state or national highways (7). High-velocity trauma that occurs on highways results in more-severe injuries and may be responsible for the poorer outcomes. Accidents in the city usually occur at lower velocities, with lesser severity of injury.

Pedestrians and persons on two-wheelers accounted for 74.6% of the fatalities in our study. Pathak et al. (8) found that the greatest number of RTAs in western India involved motorized two-wheelers. The high mortality in this group is due to factors such as speeding, disregard for traffic laws, lack of safety gear, and faulty vehicle or road conditions. Fitzharris et al. (9), in a study of urban India, showed that the failure to wear a helmet correctly led to a five-times greater likelihood of intracranial injury, and that as many as 84% of pre-hospital deaths occurred in two-wheeler riders not wearing helmets. Our study also found that pillion riders had a significantly higher risk of death than drivers. There have been conflicting findings in other studies (9).

Pedestrians, along with two-wheeler vehicle passengers, account for the highest RTA mortality rate in India (10). We discovered that most of the pedestrian accidents and deaths occurred as the victim crossed the road. In India, traffic laws for pedestrians are far from satisfactorily implemented. One hundred twenty-one patients in our study experienced RTAs while travelling in four-wheeler vehicles, and front-seat occupants were more likely to suffer fatalities than rear-seat passengers. All of the ejection injuries occurred in front-seat occupants not wearing seatbelts. An absence of safety gear, such as seatbelts and airbags, was significantly associated with increased mortality. Few motorists regularly wear seatbelts in India (11).

Three-wheeler auto-rickshaws are peculiar vehicles

found on Indian roads. The vehicle itself has an unstable design and is very prone to overturning. Our center is located in a part of the city where these vehicles are banned, and we believe this is why we saw a very low number of RTAs related to these vehicles in our study. A study conducted by Schmucker et al. (12) in India showed that almost 73% single-vehicle RTAs were overturned auto-rickshaws. Lower injury scores were seen in that study, in which a 12% mortality rate was observed in crashes involving, motorized rickshaws in urban India.

Our study included only a modest number of RTAs involving heavy motor vehicles. Heavy motor vehicles have been identified as the most common offending agents in RTAs in studies conducted in semi-urban and rural India (13). Overloaded goods trucks, long working hours for truck drivers, highway travel, low wages, and risky behavior, such as driving under the influence of alcohol, are some of the known causes of accidents involving heavy motor vehicles (14).

Details regarding the speed of the vehicles involved in RTAs were not analyzed in our study because there was no objective data available in this regard. Approximate speeds reported by eyewitness accounts would have been inaccurate. It is obvious that high-speed crashes lead to more severe injuries and are more likely to result in death. In India, there are almost no provisions for detecting the speed of a vehicle on the road. It has been shown that the detection of speed itself can be instrumental in preventing motorists from speeding (15). Blood alcohol levels were tested only upon police request, when it was deemed necessary for the investigation. A higher number of patients reported alcohol use, had the odor of alcohol on their breath, or were suspected to have alcohol intoxication upon observation by the attending doctor. Das et al. (16), in a systematic review, found that various studies in India attribute 6% - 48% of fatalities and 2% - 33% of injuries from RTAs to alcohol intoxication. The use of other intoxicants and their influence on RTA outcomes is under-reported in India (16).

Surprisingly, traffic-rule violations were seen in the RTAs of as many as 589 patients (76.19%) in our study. In a study carried out in Hyderabad, the authors found that drivers of two-wheeler vehicles and auto-rickshaws committed the most traffic violations (17).

Pre-hospital emergency services in India are either not available or are largely under-utilized. We observed that inappropriate pre-hospital transfers and first aid led to increased mortality. Accidents occurring > 10 km from the trauma center and delayed arrival of the patient to the healthcare facility were also correlated with increased mortality. Developed countries have managed to achieve reduced morbidity and mortality related to trauma by providing prompt and appropriate pre-hospital care (18). In developing countries, on the other hand, studies show delayed transfers to hospitals and inadequate pre-hospital care (19).

There were a few limitations to our study. It was a hospital-based study, and there were several lacunae in vital data, such as vehicle speed, road conditions, weather conditions, and use of mobile phones while driving, which could have helped in interpreting the results. Deaths that occurred at the RTA site were under-reported, and many victims of non-fatal RTAs who were not admitted to the hospital were excluded. Mortality is an outcome affected by several variables. We attempted to study the impact of pre-hospital events on mortality, but events in the hospital, surgical interventions, and complications can also contribute to mortality.

In conclusion, we were able to identify a few factors related to increased mortality from RTAs. Patient-related factors, such as young age and male gender, showed trends but did not reach statistical significance. Vehicle-related factors, such as lack of safety gear, were significantly associated with mortality. Event-related factors, such as distance from the trauma center and delayed arrival, had a significant impact on mortality. Pedestrians crossing roads and two-wheeler riders require special attention if we intend to reduce mortality in these groups. We propose that to reduce the burden of RTAs, we need strong legislation regarding traffic laws and regulations. Traffic offences should be detected with technologies such as closed-circuit cameras and speed gauges, and appropriate punishments may deter motorists from committing offences. As a personal responsibility, individuals must avoid driving while under the influence of alcohol, while excessively sleepy or fatigued, or during any sort of mental agony. Vehicles must be equipped with safety gear, such as seatbelts and airbags. Wearing helmets while on two-wheelers should be made mandatory, and failure to comply should be penalized. There must be an emphasis on emergency trauma care in the pre-hospital setting, as early transport of the injured patient to a hospital offers the best chance of survival. It has been demonstrated that ultimately, road traffic accidents can truly be reduced when individual maturity regarding road-safety practices is attained (20).

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Footnotes

Authors' Contribution: Study concept and design: Ananthnarayan Chandrasekharan; acquisition of data: Ananthnarayan Chandrasekharan; analysis and interpretation of data: Aditya J Nanavati; drafting of the manuscript: Aditya J Nanavati; critical revision of the manuscript for important intellectual content: Sandhya Prabhakar; statistical analysis: Aditya J Nanavati; administrative, technical, and material support: Sandhya Prabhakar; study supervision: Subramaniam Prabhakar.

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