Epidemiology of road traffic injury patients presenting to a tertiary hospital in Hyderabad, India

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Background. *Road traffic injuries kill more people in India than in any other country in the world, and these numbers are rising with increasing population density and motorization. Official statistics regarding road traffic injuries are likely subject to underreporting. This study presents results of a surveillance program based at a public tertiary hospital in Hyderabad, India.*
Methods. *All consenting patients who presented to the casualty ward after a road traffic injury over a 9-month period were enrolled. Interviews were performed and data abstracted from clinical records by trained research assistants. Data included demographics, injury characteristics, risk factors, safety behaviors, and outcomes.*
Results. *A total of 5,298 patients were enrolled; their mean age was 32.4 years (standard deviation 13.8) and 87.3% were men; 58.2% of patients were injured while riding a motorcycle or scooter, 22.5% were pedestrians, and 9.2% used motorized rickshaws. The most frequent collision type was skid or rollover (40.9%). Male victims were younger than female victims and were overrepresented among motorized 2-wheeler users. Patients were most frequently injured from 1600 to 2400. A total of 27.3% of patients were admitted. Hospital mortality was 5.3%, and 48.2% of deaths were among motorized 2-wheeler users.*
Conclusion. *This is one of the few prospective, hospital-based studies of road traffic injury epidemiology in India. The patient population in this study was similar to prior hospital-based studies. When compared to government surveillance systems, this study showed motorized 2-wheeler users to be more frequently represented among the overall population and among fatalities. Further research should be done to develop interventions to decrease mortality associated with 2-wheeled vehicles in India. (Surgery 2017;162:S77-S84.)*

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ROAD TRAFFIC INJURIES (RTI) kill an estimated 1.24 million people around the world each year, making RTI the eighth leading cause of death worldwide.[1] Approximately 80% of these deaths occur in middle-income countries. Mortality rates and economic costs are due to increase dramatically in many of these countries if present trends continue.[2] In the past decade, this mounting public health problem has drawn increasing notice and action around the world.[3]

The Global Road Safety program (GRS) was begun in 2010, with funding from the Bloomberg Philanthropies and a consortium of partners, including the World Health Organization (WHO), the World Bank, the Association of Safe International Road Travel, the World Resources Institute, the GRS Partnership, and the Johns Hopkins

Supported by the Bloomberg Philanthropies' Global Road Safety Program (grant number 111882).

Accepted for publication January 25, 2017.

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0039-6060/$ - see front matter

http://dx.doi.org/10.1016/j.surg.2017.01.029

Bloomberg School of Public Health.[4,5] The GRS has worked to reduce the burden of road traffic injury in 10 low- and middle-income countries around the world, engaging in a variety of activities, including improved injury surveillance.[6]

India has a population of 1.213 billion people,[7] and the WHO estimates that it has 231,027 RTI fatalities each year, the most of any country in the world.[1] India's Ministry of Road Transport and Highways and Ministry of Home Affairs report that India experienced between 443,001 and 486,476 road traffic collisions in 2013, a rate of 36.1 to 39.9 collisions/100,000 population, causing an estimated 137,423 to 137,525 deaths.[8,9] Both the medical and nonmedical direct costs impose a substantial burden on Indian RTI victims, a burden that rests particularly heavy on the poor.[10] The indirect cost of lost productivity from RTIs, however, creates an even greater burden, up to 94 times as high as the direct costs,[11] leading to India's estimated 3% loss in gross domestic product.[1]

Indian government statistics rely on reports to police and traffic agencies. In surveys of patients at urban medical facilities, up to 98.1% of fatal cases are reported to police, but this drops to 77.8% when data are collected in urban community surveys.[12] Only 24.6% of nonfatal injuries presenting to emergency departments and only 2.3% of injuries presenting to outpatient centers are reported. Underreporting may be an even greater factor in rural areas and may account for the nearly 2-fold discrepancy between the WHO's community survey–based figures and government report–based figures for annual RTI fatalities. Furthermore, the 2 government RTI surveillance systems record very little information about safety behaviors or the medical care given for RTI.[13] Given these issues, additional data sources are needed for a more accurate view of RTI in India. Hospital-based surveillance provides one alternative, with the advantage that it allows for data to be collected regarding a wide variety of injury characteristics and risk factors.[14]

The present study was designed as part of the GRS to provide high-quality epidemiologic data on RTI in India. This article presents an injury surveillance program at a public hospital in Hyderabad to inform injury prevention efforts in the region and around India.

MATERIALS AND METHODS

This study was conducted in the casualty ward of Gandhi Hospital, which at approximately 1,200 beds is the second largest public teaching hospital in Hyderabad, Telangana State (metropolitan area population 5.74 million).[7] Emergency care, including computed tomography studies and operations, is provided free of charge at Gandhi Hospital.

Research assistants received 19 hours of classroom instruction regarding research ethics, patient confidentiality and consent, trauma care, and data collection. A research assistant was stationed in the casualty ward at all times, with frequent visits by a supervisor responsible for data accuracy and consistency. Data were prospectively collected from September 1, 2013, to May 31, 2014. Patients presenting to the casualty ward after an RTI were identified by medical staff or from a register kept for medicolegal documentation. Verbal consent was obtained from patients or family members.

Data were recorded in an RTI registry using a standardized, paper-based collection tool. Data were collected regarding patient demographics, injury characteristics and location, RTI risk factors, safety behaviors, and medical information about both the initial presentation and subsequent hospital course. Initial data collected at the time of hospital presentation included physiologic parameters, anatomic location of injury, and injury typology. Up to 3 procedures or operations were recorded for each subject. Physiologic data were used to calculate a Revised Trauma Score for each patient.[15] Disposition from the casualty ward was recorded for subjects presenting before January 1, 2014, and disposition from the hospital was recorded for subsequent patients. For patients who presented on or after January 1, 2014, there was no direct recording of whether patients were admitted to the hospital. For these patients, a hospital duration of stay greater than 24 hours was used as a proxy value for admission.

Data were entered in Excel (Microsoft, Redmond, WA), and statistical analysis was performed using Stata SE13.1 (StataCorp, College Station, TX). Bar charts were created using Stata and pie charts using Excel. Univariate and bivariate analyses were performed for demographic characteristics and outcomes. The Mann-Whitney U test was used to assess non-normal continuous variables with unequal variances, and the Pearson χ^2 test was used to assess categorical variables. Simple logistic regression was used to analyze odds ratios for mortality and inpatient admission; multiple logistic regression models were constructed from the significant variables from simple regression.

This study was approved by the Institutional Review Board of the Johns Hopkins Bloomberg

School of Public Health and the Ethics Committee of the Indian Institute of Public Health.

RESULTS

A total of 5,298 RTI patients presented to the casualty ward of Gandhi Hospital during the study period, an average of 589 per month (range: 512–707). The mean age was 32.4 years (standard deviation [SD] 13.8, range 0–90), 87.3% of patients were men, and 60.8% of RTIs occurred within the city of Hyderabad (Table I). Socioeconomic status was measured via education level; 40.2% of patients had no formal education, but 25.7% had a college education and 5.0% a professional degree. The most common occupation was day laborer (29.1%), followed by salaried employee (24.9%), student (17.8%), and self-employed (16.2%). Sex and location of injury were recorded for all patients; age data were missing for 5 subjects (0.09%), education level for 16 (0.30%), and occupation for 14 (0.26%).

The majority of patients were injured while operating or riding motorized 2-wheeled vehicles (58.2%) (Fig 1, *A*). The next most common injury mechanisms were pedestrian (22.5%) and motorized rickshaw (9.2%). Most pedestrians were injured while crossing roadways (50.7%), with nearly as many injured while walking or standing on the roadside (44.4%). Among patients injured on motorcycles, 83.4% were operating the vehicle while 16.6% were passengers. Car and van occupants were nearly evenly divided, 44% operators and 55% passengers with 1% unknown. Those injured on motorized rickshaws and buses were much more often passengers (61.2% and 97.9%, respectively) than operators.

The vehicle or object that the patient struck, or was struck by, was recorded for 5,266 patients (99.4%) (Fig 1, *B*). The most frequent collision type was a skid or rollover without a second object's involvement (40.9%), followed by collision with a motorcycle (17.7%), car (9.6%), or motorized rickshaw (9.5%). A small proportion of patients fell from a moving vehicle (4.0%), although this proportion was higher among patients who had been bus occupants (22.8%).

Men were younger than women, with a mean age of 31.9 years compared to 35.6 years for women ($P < .0001$) (Table II). Patients' modes of transportation also varied significantly with sex ($P < .0001$). Men were overrepresented among those patients using motorcycles, bicycles, and trucks; women were overrepresented among pedestrians and those patients using cars or vans and buses. When motorcycle passengers were considered separately from operators, women were much more frequent (200/511, 39.1%). Admission rates were not significantly different between men and women (27.6% vs 25.5%, $P = .26$).

Table I. Demographic characteristics of study population

Variable	n *(%)*
Age	
0–14	253 (4.8)
15–29	2,338 (44.1)
30–44	1,597 (30.1)
45–59	800 (15.1)
≥60	305 (5.8)
Unknown	5 (0.1)
Sex	
Male	4,623 (87.3)
Education	
None	2,124 (40.1)
Primary	406 (7.7)
Secondary	1,130 (21.3)
College	1,356 (25.6)
Professional	266 (5.0)
Unknown	16 (0.3)
Occupation	
Unemployed	224 (4.2)
Student/child	942 (17.8)
Housewife	287 (5.4)
Beggar	28 (0.5)
Self-employed	856 (16.2)
Day laborer	1,535 (29.0)
Salary	1,313 (24.9)
Farmer	40 (0.8)
Other/unknown	20 (0.4)
Retired	53 (1.0)

Injury mechanisms were distributed unequally among age strata ($P < .0001$). The majority (53.0%) of patients aged 15 to 29 were injured in motorcycle collisions (Table III). Patients under the age of 15 and over the age of 59 were overrepresented among pedestrians and bicycle injuries. Adults aged 30 to 44 were overrepresented among those injured in trucks.

Patients were least frequently injured between 0400 and 0800 and most frequently injured between 1600 and 2400 for each day of the week. While the nadir was consistent for each day, the evening peak of injuries was much more pronounced on Sundays and to a lesser extent on Saturdays (Fig 2). On Mondays through Fridays, times of injury were spread evenly throughout the day with the exception of the early morning hours.

For the 2,323 patients whose disposition from the casualty ward was recorded, 667 (28.7%) were

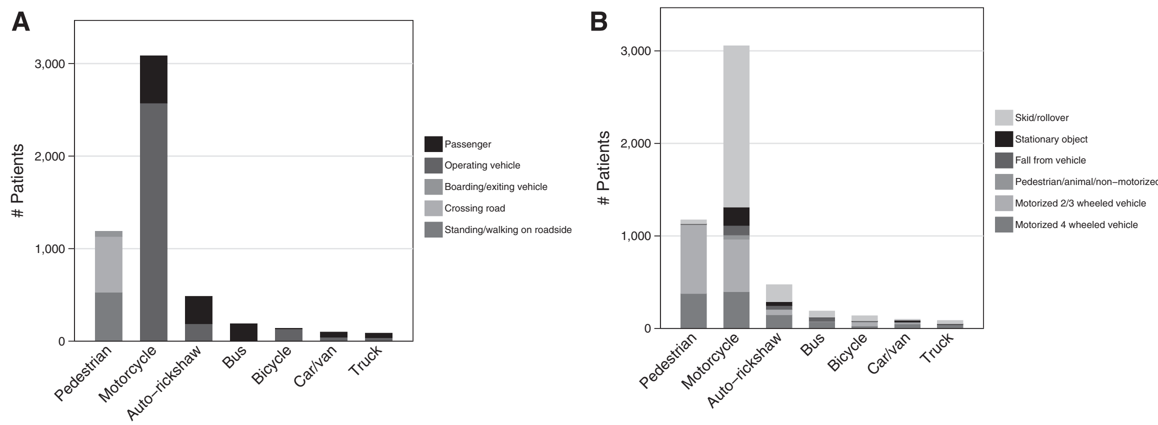

Fig 1. (*A*) User activity by subject's mechanism of injury (24 subjects for whom vehicle type, and 2 subjects for whom user activity were "other/unknown" are not shown in this figure). (*N* = 5,278.) (*B*) Type of collision by subject's mechanism of injury (24 subjects for whom mechanism, and 52 subjects for whom collision type were "other/unknown" are not shown). (*N* = 5,228.)

Table II. Comparison of age, mechanism, and admission status by sex

	Males (N = *4,620)*	*Females* (N = *673)*	P *value*
Age, mean (SD)	31.9 (13.1)	35.6 (17.3)	<.001
Mechanism, *N* (%)			<.001
Pedestrian	938 (78.8)	252 (21.2)	
Car/van	82 (82.0)	18 (18.0)	
Bus	152 (80.4)	37 (19.6)	
Motorcycle	2,826 (91.6)	258 (8.4)	
Rickshaw	383 (79.0)	102 (21.0)	
Bicycle	137 (98.6)	2 (1.4)	
Truck	83 (95.4)	3 (4.6)	
Unknown	22 (91.7)	2 (8.3)	
Admitted, *N* (%)	1,247 (27.6)	172 (25.5)	.26

For patients whose admission status was not recorded (*N* = 2,975), a hospital stay >24 hours was used as a proxy for inpatient admission.

admitted as inpatients. Only 10 of these 2,323 patients had a recorded duration of stay in the casualty ward greater than 24 hours (range: 24.9–410.0), of whom 4 were admitted to inpatient and 6 were discharged from the casualty ward. For the 2,975 patients presenting during 2014 for whom admission status was not directly recorded, 779 (26.2%) had durations of stay >24 hours. Combining this proxy measure of admission with the patients who were recorded as admitted from the casualty ward, a total of 1,446 out of 5,298 patients (27.3%) were admitted.

Among the 2,323 patients presenting in 2013 with known dispositions from the casualty ward, 35 (1.5%) died, 4 (0.2%) proceeded directly to operation, 58 (2.5%) were transferred to another health care facility, 1,459 (62.8%) were treated and discharged from the casualty ward, and 100 (4.3%) left against medical advice (Fig 3, *A*). Of the 2,598 patients presenting in 2014 with known dispositions from the hospital, 158 (5.3%) died, 2,468 (83.0%) were treated and discharged, 344 (11.6%) left against medical advice, and 5 (0.2%) were transferred to another health care facility (Fig 3, *B*).

Regression analysis for inpatient mortality was used only for those patients whose disposition from the hospital was known (*N* = 2,975). In simple logistic regression, mortality had a positive association with increasing age, arriving at the hospital by ambulance, arriving intoxicated by alcohol, and being injured as a pedestrian; there was a negative association with revised trauma score and having at least a secondary school education. There was no significant effect of sex on inpatient mortality. In multivariate analysis, only age, revised trauma score, and arrival by ambulance had a significant correlation with mortality (Table IV).

A total of 80 patients were recorded as dying from RTI sustained within the city of Hyderabad. Among the patients who died, 48.2% were motorized 2-wheeler users, 31.6% were pedestrians, and 7.8% were motorized rickshaw users.

DISCUSSION

In the absence of national or regional hospital-based surveillance systems, this is one of the largest prospective hospital-based studies of RTI epidemiology in India. Smaller studies have covered those patients injured in collisions of a particular vehicle type,[16-19] or with injuries to a particular organ system.[20-24] For example, Roy et al[25] reported a

Table III. Distribution of age groups by subject's mode of transportation (n, %)

	RTI mechanism							
Age group (y)	*Pedestrian*	*Car/van*	*Bus*	*Motorcycle*	*Rickshaw*	*Bicycle*	*Truck*	*Total*
<15	98 (8.3)	6 (6)	6 (3.2)	77 (2.5)	23 (4.8)	36 (25.9)	4 (4.6)	250 (4.7)
15–29	320 (27.0)	36 (36)	83 (43.9)	1,635 (53.0)	186 (38.5)	34 (24.5)	37 (42.5)	2,331 (44.2)
30–44	363 (30.6)	39 (39)	50 (26.5)	920 (29.8)	160 (33.1)	27 (19.4)	32 (36.8)	1,591 (30.2)
45–59	251 (21.1)	15 (15)	32 (16.9)	368 (11.9)	89 (18.4)	28 (20.1)	13 (14.9)	796 (15.1)
≥60	155 (13.1)	4 (4)	18 (9.5)	84 (2.7)	25 (5.2)	14 (10.1)	1 (1.1)	301 (5.7)
Total	1,187 (100)	100 (100)	189 (100)	3,084 (100)	483 (100)	139 (100)	87 (100)	5,269 (100)

N = 5,269; age information missing for 5 subjects and mechanism information missing for 24 subjects.

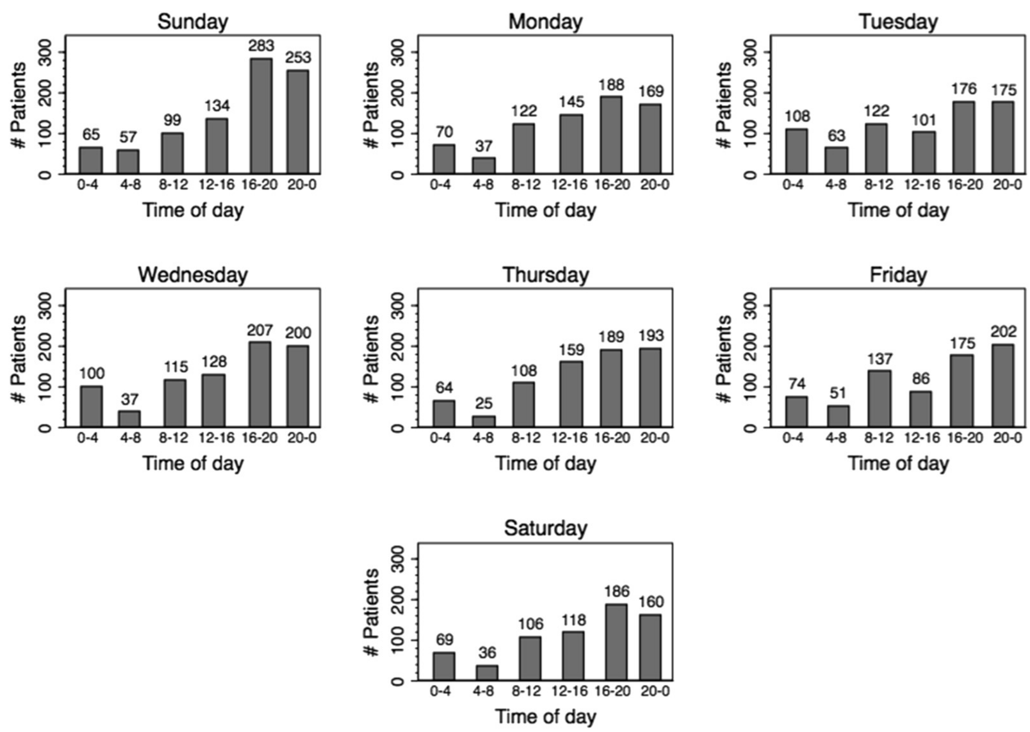

Fig 2. Time of injury by day of week. Time given as hours on 24-hour clock. Time of injury data were missing for 6 patients, not shown in this figure (N = 5,292).

hospital-based study of 161 injured patients presenting to a tertiary care center in Mumbai, 74 (46.0%) of them after RTI, but describe mostly prehospital care and transportation with little epidemiologic detail. Dhingra et al[26] published a report of 2,446 injured patients presenting to a tertiary care hospital in Delhi in 1987; RTI victims constituted 38.0% of the study population, but the report contains few details of their demographics or injury patterns.

Celine and Antony[27] published a retrospective series of 7,660 RTI patients presenting to a tertiary hospital in Kerala over a 6-year period; 92.42% of their patients' vehicles were coded as "other," making comparison to our population difficult. Uthkarsh et al[28] published a hospital-based epidemiologic study of patients presenting to a tertiary care hospital in Bangalore; of 363 injured patients, 69.1% were RTI victims. The overall population demographics were similar to our study: the mean age was 35.3 years, and 85.4% of patients were men. Modes of transportation were somewhat different in that study from ours: pedestrians made up 17.1% of their RTI patients vs 22.5% of our population, motorized 2-wheelers 61.0% of their RTI vs 58.2% of our population, and cars made up 9.6% of their population vs 1.9% of our population. Because both studies were performed

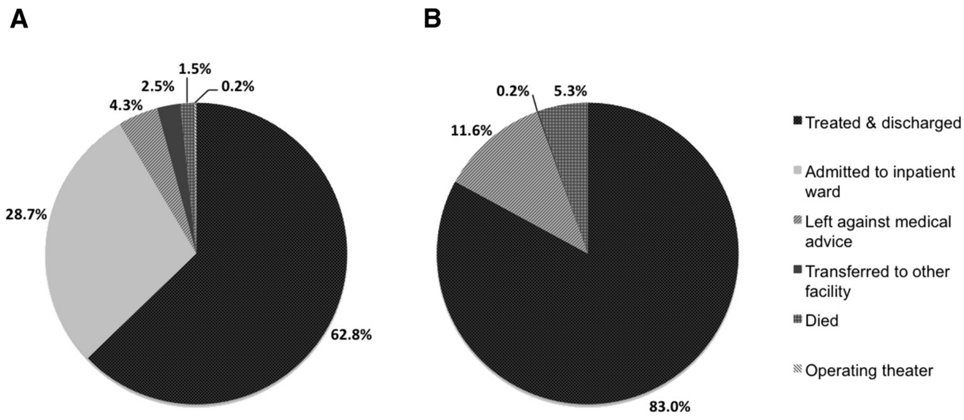

Fig 3. Dispositions from the casualty ward and hospital. Data collection regarding disposition changed in January 2014; for patients before this time (*A*), only disposition from the casualty ward is known; for patients after this time (*B*), hospital disposition is known but admission status was not directly recorded. ($N = 5{,}298$).

Table IV. Correlates of inpatient mortality ($N = 2{,}975$)

Variable	*OR*	*SE*	*P*
Simple logistic regression			
Age	1.026	0.006	<.001
Sex	0.907	0.228	.697
RTS	0.420	0.023	<.001
Education	0.424	0.074	<.001
Pedestrian	1.463	0.260	.031
Ambulance	13.879	6.333	<.001
Intoxication	1.034	0.001	<.001
Multiple logistic regression			
Age	1.019	0.007	.010
RTS	0.444	0.025	< .001
Educated	0.681	0.154	.089
Pedestrian	0.954	0.215	.834
Ambulance	5.143	2.412	< .001
Intoxication	0.987	0.121	.182

OR, Odds ratio; *RTS*, revised trauma score; *SE*, standard error.

at a single institution in different cities, it is impossible to discern whether these discrepancies are due to regional or institutional factors.

The most useful comparisons for this study are government surveillance systems, which use data from collision reports. Hyderabad had 496 RTI fatalities in 2013 according to the National Crime Records Bureau and 482 according to the Transport Research Wing.[8,9] Our study counted 80 deaths from collisions that occurred in Hyderabad over a 9-month period, with the caveats that only deaths in the casualty ward were recorded for the first 4 months of the study, and data were collected only at one of numerous hospitals in the city. Given the limited nature of our mortality data collection, it seems likely that the report-based surveillance systems give a significant underestimate of RTI fatalities in Hyderabad.

The Transport Research Wing reported that 26.2% of "accidents" were from motorized 2-wheelers, much lower than our data and other hospital-based studies that showed a proportion in the range of 58.2% to 61.0%. The government agencies reported 21.4% to 24.9% of RTI deaths were from motorized 2-wheelers, the WHO reported 32%,[1] and our data showed 48.2%. It seems unlikely that these patients would be more likely than other road users to present to a hospital prior to dying; a more likely explanation for this discrepancy is that these vulnerable road users' deaths are less frequently documented in official reports. The government agencies also show the highest number of road traffic injuries occurring from 1500 to 2100, roughly consistent with our data showing the plurality of victims being injured between 1600 and 2400, especially on weekends.

Age, injury severity, and arrival by ambulance were all associated with inpatient mortality in multivariate logistic regression. Of these, arrival by ambulance was by far the most predictive, with an odds ratio of 5.143. It bears mention that this study was observational; this should not be interpreted as implying that ambulance transportation plays a causative role in RTI patients' mortality at Gandhi Hospital. The most likely explanation for this association is that the patients transported by ambulance are more severely injured or more vulnerable than those brought to the hospital by private transportation in a way that is not adequately measured and therefore controlled for by the physiologic parameters used for calculation of the Revised Trauma Score: blood pressure, Glasgow Coma Score, and respiratory rate.

This confirms that ambulance crews in Hyderabad and its environs are correctly identifying and transporting the most severely injured patients.

This study does have limitations due to its design. As a hospital-based study, only those patients who presented to medical care were included. Many patients with minor injuries likely did not present to this tertiary hospital. Mortuary studies suggest that a majority of Indian RTI patients with severe head injuries die before reaching a hospital.[22] Unlike population-based studies, our study cannot be used to estimate incidence among the general population. This study was an injury surveillance study, not a trauma registry[29]; as such, limited data were collected on injury severity, making it difficult to perform risk stratification for patients. Very few data were missing (eg, no missing data for sex, 0.3% for occupation, and 5.9% for systolic blood pressure); this testifies to the diligence of our registrars.

Surveillance data such as these may be used to improve RTI prevention efforts. Vecino and Hyder[2] have identified 5 major risk factors for RTI mortality in middle-income countries, with failure to use helmets on motorcycles and seatbelts in cars standing out as particularly problematic for India. Gururaj[30] has enumerated several helpful prevention efforts for India, including organized RTI prevention campaigns, traffic calming measures, and daytime headlight use. Given the preponderance of injuries occurring in the evening hours in this series, improvements in lighting, rush hour traffic calming measures, and other interventions to improve evening traffic safety may be helpful as well, although further research will be needed to assess their effectiveness. This study underscores the importance of prevention efforts aimed at users of motorized 2-wheelers, a vulnerable group of road users who are strongly represented in the urban trauma population.

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