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Identification of unsafe locations for traffic injuries on highways

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ABSTRACT: The increasing frequency and severity of recent Road Traffic Accidents (RTAs) in India involving modern vehicles have caused grave concern for road safety, posing serious challenge to transport policy makers, planners, regulators, police, engineers and civil society alike. With just 1% of world's vehicles, India leads with 10% of world's total Road Traffic Fatalities (RTFs) of 1.3 million, resulting in untold misery to lakhs of people, the nation losing about 3%[1] of its GDP. Data with the Transport Research Wing (TRW) of the Ministry of Road Transport and Highways (MORTH) and the National Crime Records Bureau (NCRB) of India indicate an alarming rising trend during 2002-2011 in the number of RTAs, the leading cause of unnatural death in India. RTAs constitute the 8th leading cause of deaths in the world[1] in 2011, 77% of them being men. The UN General Assembly Resolution 64/255 of 2010 declared 2011-20 as the 'Decade of Action for Road Safety'. Less than 35% of low and middle income countries have policies in place to protect the road users. Road safety was recognized in global environmental policy deliberations at the recent Rio+20 UN Conference on Sustainable Development. Sustainable transport policy has to include promoting Public Transport and making Non-Motorized Transport (NMT) options accessible and safe, signifying the need to expand alternate transport systems like railways and inland waterways. In this backdrop, an analysis of the RTA related issues and the underlying causes is made, and possible way forward is attempted.

Key words: Road accidents, fatalities, causes, safety, railways, waterways.

INTRODUCTION

Of all the systems with which people have to deal everyday Road Traffic Systems (RTS) are the most complex and the most dangerous [1]. With the transit of human race from 19th to 20th century a slow transition started in the cause of deaths from infectious to noninfectious agents. By the advent of 21st century Road Traffic Injuries (RTI) emerged as one of the major cause of injuries and deaths worldwide in the post transition era. RTIs are the leading cause of deaths, hospitalization and disabilities in India. In India RTIs result in death of more than 100000 persons, 2 million hospitalizations, 7.7 million minor injuries and an estimated economic loss of 55000 crores or nearly 3% of GDP every year. The available data reveals that nearly 10-30 % of hospital registrations are due to RTIs and majority of those hospitalized are discharged with varying levels of disabilities. Road crash injury is largely preventable and predictable; it is a human-made problem amenable to rational analysis and countermeasures. In the 1960s and early 1970s many highly motorized countries began to achieve large reductions in casualties throughout come oriented and science-based approaches. The health sector has an important role to play in establishing data systems on injuries and the effectiveness of interventions, and the communication of these data to a wider audience. Many studies were carried in India based on hospital records, which were mainly limited to metropolitans and large cities. All the studies either use number of accidents or victims according to availability of accident data. Studies combining these two types of data to identify unsafe locations are a rarity. In this study data on both, the number of accidents and severity of RTIs is used to identify unsafe locations.

Road markings are used as a means of controlling and guiding traffic. They are highly important on urban roads and intersections as they promote road safety and bring out smooth and harmonious flow of traffic along guided paths of travel. They also supplement the messages conveyed by road signals and signs. In some cases, they are used alone to convey certain regulation, information or warning that cannot otherwise be effectively made known to the road users. Road surface markings are the devices on a road surface in order to convey official information. Road surface markings are used on paved roadways to provide guidance and information to drivers and pedestrians. Uniformity and standardisation of the markings is an important factor in minimizing confusion and uncertainty about their meaning. These do help in reducing the accidents and manpower requirements for regulating traffic.

Materials and Methods

The objective of the study is to identify unsafe locations for Road traffic injuries in and around Rohtak city and identify factors responsible for accidents at these sites. The study area includes Rohtak Municipal Corporation and the area around Rohtak city with in the radius of 10 km from the centre of Rohtak city. Road traffic injury data for complete year is collected from Government General Hospital, Rohtak. Almost all the accident cases in and around Rohtak approach this medical facility for medical care. The hospital has an accident register, which maintains the preliminary data of all accident cases coming to the facility. For reasons of clear data collection, only harm involving a road vehicle is included. A person tripping with fatal consequences on a public road is not included as a road-traffic fatality. To be counted a pedestrian fatality, the victim must be struck by a road vehicle. Preliminary data regarding these cases is collected from accident registers. These cases are followed till a complete assessment of injuries is carried out in their respective wards. As the current study uses injuries succumbed and post injury status to assess the outcome of RTI by calculating probability of survival using Trauma score – injury severity score methodology, the treatment given and outcome is not recorded except for the deaths to know the fatality rates.

Using the values of Indian coma scale (ICS), Systolic Blood Pressure (SBP) and Respiratory Rate (RR) of the cases at the time of admission Revised trauma score for each case is calculated. The Revised Trauma Score is a physiological scoring system, with high inter-rater reliability and demonstrated accuracy in predicting death. RTS = 0.9368 GCS + 0.7326 SBP + 0.2908 RR Values for the RTS are in the range 0 to 7.8408. The RTS is heavily weighted towards the Indian Coma Scale to compensate for major head injury without multisystem injury or major physiological changes. The RTS correlates well with the probability of survival. Depending on the type of injury, Abbreviated injury score is calculated for each case. Injuries are ranked on a scale of 1 to 6, with 1 being minor, 5 severe and 6 an unsurvivable injury. From Abbreviated Injury Score (AIS), Injury severity score is calculated. The Injury Severity Score is an anatomical scoring system that provides an overall score for patients with multiple injuries. Each injury is assigned an Abbreviated Injury Scale score and is allocated to one of six body regions (Head, Face, Chest, Abdomen, Extremities (including Pelvis), and external). Only the highest AIS score in each body region is used. The 3 most severely injured body regions have their score squared and added together to produce the ISS score.

The widely used technique – Trauma score – injury severity score methodology is used to evaluate probability of survival for each patient involved in a single or multiple body region injury by referencing the patient's anatomical injury and post-injury physiological status. Anatomical injury data for each body-region were coded by the Abbreviated injury scale and used as input for the Injury severity score for either single or multiple body-region injury. Post injury physiological status was assessed from the Revised Trauma Score which depended upon the value of systolic Blood pressure, Respiratory Rate and consciousness status as called the Indian coma scale. The Probability of Survival (PS) value is calculated by using equations:

PS = 1/ 1+ e-b

Where 'b' is calculated:

b = b0 + b1 (RTS) + b2 (ISS) + b3 (AGE)

The coefficients b0 - b3 are derived from multiple regression analysis of the Major Trauma Outcome Study database. Age Index is 0 if the patient is below 54 years of age or 1 if 55 years and over. b0 to b3 are coefficients, which are different for blunt and penetrating trauma. If the patient is less than 15, the blunt coefficients are used regardless of mechanism. Unsafe Index (HI) is calculated from PS. HI is composed of two dimensions of accident frequency and severity. To obtain the HI, it was assumed that severity and frequency of accident occurrences are mainly perceived factors, which normally be used to discriminate whether such locations are unsafe.

$$HI_i = \frac{N_i}{N^m} {}_{j=1}^{j=j} (1 - PS_{ij})$$

Where,

HIi = Unsafe Index for location i
Ni = Number of accident cases occurred on location I
Nm= Maximum number of accident cases observed for all locations
PSij = Probability of Survival estimated for patient jth after involved an accident occurrence in location or situation i.

Pedestrian Crossings

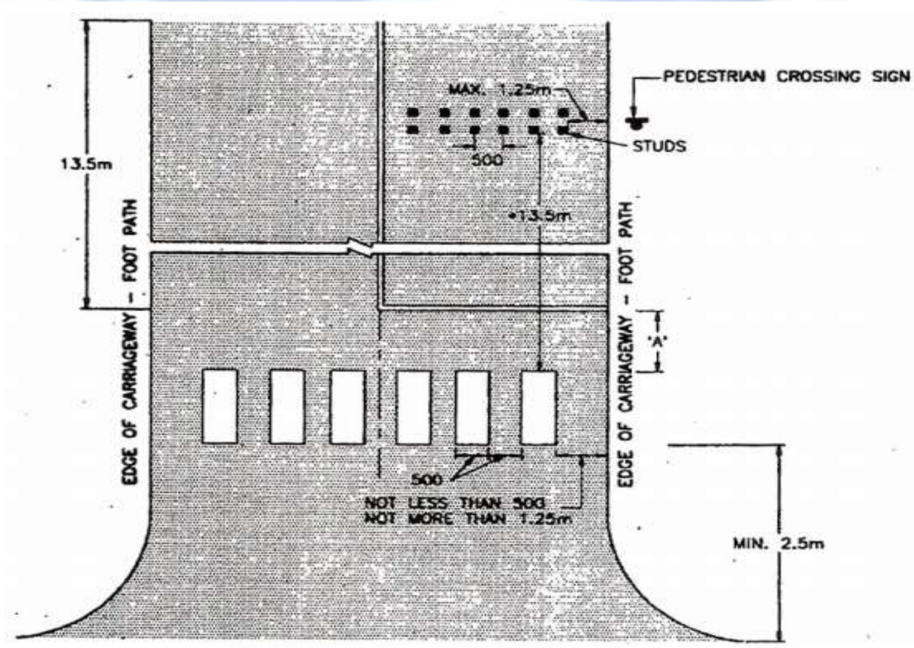
Crossing of the carriageway by pedestrians, only at the unauthorized places minimizes the confusion. As a result of this, the number of pedestrian casualties is reduced and the tendency to jaywalk is curbed. The success of pedestrian's crossings in controlling both vehicular and pedestrian's traffic depends to a greater extent on where and how they are marked. Pedestrian crossings shall be provided at important intersections where conflict exists between vehicular and pedestrian movements. The site should be so selected that the pedestrians are subjected to minimum inconvenience and the vehicular traffic too is not interrupted very often. The location of pedestrian crossing at intersections should fulfill the following conditions to ensure safety of traffic.

i) Adequate visibility so that the driver of approaching vehicle has clear view of the persons on the pedestrian crossing and on the pedestrian footpath;

ii) Sufficient space on the footpath for the pedestrians to wait; and

iii) Freedom from obstruction such as trees, sign posts, lamp posts, etc., in the path of

pedestrians at either end of the pedestrian crossing. For dimensions and positioning of pedestrian crossings, IRC: 103-1988 ³Guidelines for Pedestrian Facilities´, may be referred. At intersections, the pedestrian crossings should invariably be preceded by a stop line at a distance of 2 m to 3 m for unsignalised intersections and at a distance of 1m for signalized intersection (Refer Fig.1.) The width of the pedestrian crossing is governed by the pedestrian volumes crossing the road and by local requirements but in no case should it be less than the width of footpath subject to a minimum of 1.5 m. The width of the crossing generally lies between 2 m and 4 m. Marking for pedestrian crossing mostly used is the Zebra pattern consisting of equally spaced white stripes generally 500 mm wide and they should be marked. A warning sign to indicate that the pedestrian crossing is ahead should also be installed. At mid-block pedestrian crossing in urban areas, it may be advantageous to install flashing signals along-with the markings, so that the drivers receive advance warning about the presence of the crossing.



Source: IRC 35-1997

Fig 1: Pedestrian Crossing

Directional Arrows

In addition to the warning lines on approaches to intersections, directional arrows should be used to guide drivers in advance over the correct lane to be taken when approaching busy intersections whether signal controlled or not. Because, of the low angle at which such markings are viewed, these must be elongated in the direction of the traffic flow to provide adequate legibility. Arrows irrespective of speed to be envisaged. Normally four arrows should be used in sequence in each lane. The direction arrow nearest to the intersection should be 15 m from the stop line or the entrance to the junction. The second arrow should be placed 15 m before the first arrow and similarly for third and forth arrow. Recommended designs of arrow are shown in Fig. 2. On two lane approaches to an intersection, the arrangement of arrows indicating the lanes for (a) straight ahead, (b) left turn, and (c) right turn movement, the straight ahead and left turn arrow should be combined in the left side lane. Similarly, where there is a left filter lane, the same should be marked with left arrow marking alone, in order to exclude non filtering traffic.

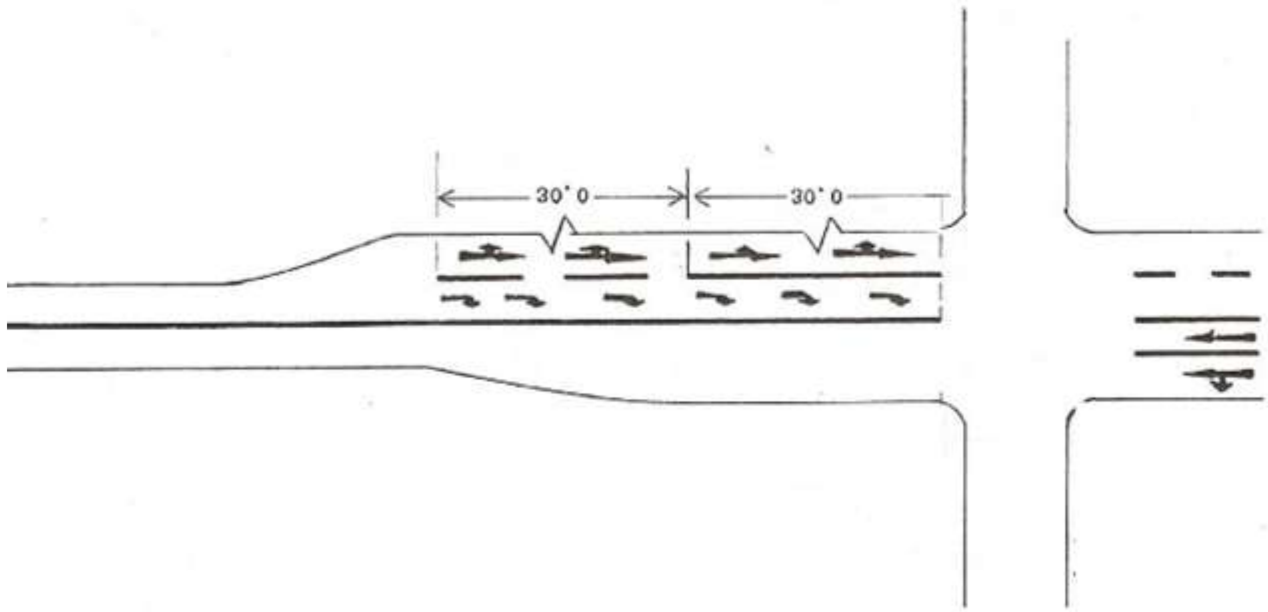


Fig 2: Arrow marking for route direction near intersection

Results

A total of 916 cases of injuries are recorded in a year from Government General Hospital (GGH), Rohtak. For all the victims probability of survival is calculated using Revised Trauma score and Injury Severity Score. From probability of Survival Unsafe Index is calculated for all the accident sites. Of all the accident sites Unsafe sites are identified with HI > 100. The results for these unsafe sites are as follows. Among all unsafe sites Kharawar Mor has maximum number of victims (table 1).

Table 1: Number of accident victims at unsafe sites

Accident site	Accident victims	Frequency (%)
Kharawar Mor	52	5.7
Gohana Road	25	2.7
Sonepat Road	36	3.9
Jhajjar Road	32	3.5
Jind Road	32	3.5
Total	177	19.3

Maximum number of victims from an accident site was from government general hospital site. As the HI of GGH site is less than 100 and it is not considered as a unsafe site. Young adults (20-30 yrs) closely followed by elder adults (40-59 yrs) are highest number of victims for RTI in all the unsafe sites (table 2).

Table 2: Age group differences of victims at unsafe sites

Accident site	1-19 yrs	20-39yr	40-59yr	> 60 yr	Total
Kharawar Mor	7	26	17	2	52
Gohana Road	3	11	11	0	25
Sonepat Road	6	14	15	1	36
Jhajjar Road	6	14	9	3	32
Jind Road	7	13	11	1	32

Very young and the elderly population are less victimized at these sites. Males are affected mostly in all the sites compared to females (table 3).

Table 3: Sex differences of the victims at unsafe sites

Accident site	Male	Female	Total
Kharawar Mor	42	10	52
Gohana Road	21	4	25
Sonepat Road	32	4	36
Jhajjar Road	31	1	32
Jind Road	27	5	32
Total	153	24	177

When injuries are studied in respect to the site of accident GGH accounted for maximum number of injury cases (6%). Kharawar Mor is the site with maximum HI (779.86) followed by Gohana Road area with HI 217.19, Sonepat Road area with HI 163.64, Jhajjar Road with HI 140.51 and Jind Road with HI 105.93.

Conclusion

If traditional methods of determining unsafe sites for road traffic accidents is followed based on either number of accidents or severity of accidents erroneous conclusions will be drawn in identifying unsafe sites. A lot of money would be wasted and engineering these sites to prevent accident injuries would be cost ineffective. While a study combining both the approaches like this study based on Unsafe Index would be more scientific, lead to correct identification of sites and thus the interventions will be cost effective.

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