

India and the management of road crashes: Towards a national trauma system

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ABSTRACT

Road trauma in India is a significant health and socio-economic burden which requires urgent attention. When compared to countries with established trauma systems, those injured in India have up to a six-fold higher mortality rate. The death rate would be reduced with better organized systems of trauma care. This is dependent on state authorities introducing systems that fund accident prevention along with the organized care of the injured. The goal of an effective trauma system should be to provide universal emergency care with equity of access. The belief that trauma care cannot be cost-effective in low-income settings needs to be refuted. Better planning will result in cost-effective improvements in patient outcomes. However, without protected and guaranteed funding schemes, the development of trauma systems in India will fail.

Key words: Funding, preventable death, trauma systems

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Accidental injury is one of the leading causes of mortality and morbidity in India. India has one per cent of total vehicles in the world but accounts for six per cent of total road accidents. There are approximately 400,000 road crashes causing injury in India each year, resulting in 85,000 deaths and 1.2 million seriously injured. The World Health Organization (WHO) has projected that by 2020 road accidents will be a major killer in India accounting for 546,000 deaths and 15,314,000 disability-adjusted life years lost.^[1,2]

WHO figures for 2000 indicate that India has a disproportionately high death rate due to road traffic injuries - 29 per 100,000 people - more than twice the rate of developed nations. Underpinning this mortality rate is India's high rate of road crashes. The accident rate of 35 per thousand vehicles in India is one of the highest in the world. There is an associated annual

fatality rate of 25.3 per 10,000 motor vehicles. This translates to a serious Indian road crash every few minutes. Many accidents are not reported. Deaths from all types of injuries are projected to increase 1.47-fold from 1990 to 2020 - with road traffic injuries the major cause for this increase.^[1,2]

Compounding the high crash incidence is the lack of organized care for the injured. Evidence indicates that people with life-threatening, but potentially treatable injuries are up to six times more likely to die in a country with no organized trauma system than in one with an organized, resourced trauma system.^[3]

The state of Kerala, for example, leads the country in certain social and health indicators such as literacy and health equity, yet has one of the highest motor vehicle crash rates in the country, with the third highest absolute number of road accidents. There are approximately

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2,500,000 registered vehicles in Kerala, with 39,500 crashes and 2,700 road accident deaths reported in 2003. This equates to an associated annual fatality rate of 12 per 10,000 motor vehicles. This compares with a comparative rate in Australia of 1.8 per 10,000 motor vehicles - a six-fold difference. Not surprisingly, road crashes are the commonest cause of death for people under the age of 35.

Apart from the human cost, the financial cost resulting from road crash injuries is significant. Death and disability following road crashes cause significant costs through years of productive life lost and the ongoing costs of care. The estimated cost of road crashes in India is two per cent of the Gross Domestic Product.^[4] For example, the direct cost per annum of road crashes in Kerala is estimated to be Rs. 300 crore per annum (US\$ 75,000,000 per annum).^[5] These costs will continue to rise if the road toll continues to increase.

INJURY PATTERNS

Published road crash data from Delhi indicates that 41% of injured are pedestrians, 27% motorcyclists and 14% pedal cyclists.^[6] Data from Kerala indicates that 56% of road crashes involve riders of two-wheeled vehicles. The majority of road crash patients do not require extrication.

A Mumbai study published in 2004 prospectively studied 1074 severely injured patients. Head trauma was present in the majority (76%) of the patients in this study and severe head injuries accounted for 47% of all patients with head injury. Severe thoracic and abdominal injuries were 0.6 and 8.2% of all the thoracic and abdominal injuries, respectively.^[7]

For most of India, the wearing of helmets for motorcyclists is not mandatory and/or not enforced. Brain injury following motorcycle crashes is common. Traumatic brain injuries are a leading cause of morbidity, mortality, disability and socioeconomic losses in India. Road traffic injuries are the leading cause (60%) of brain injury, followed by falls (20-25%) and violence (10%). Alcohol intake is known to be present among 15-20% at the time of injury. The rehabilitation needs of brain injured persons are significantly high and increasing from year to year.^[8]

PREVENTION

As previously described, prevention schemes - such as the wearing of helmets for motorcyclists - have had variable support and enforcement in India. Prevention strategies can contribute up to two-thirds reduction in road trauma mortality.

The state of Victoria in Australia has a successful history

in the reduction of deaths and disability from trauma over the past 35 years. Primary prevention including world's first mandatory seat-belt legislation in 1970, compulsory bicycle helmets, random alcohol breath testing, speed cameras and mandatory blood tests for hospitalized trauma patients substantially reduced the road toll. Between 1970 and 1994 the fatality rate decreased from 8.1 to 1.4 per 10,000 registered vehicles and from 30.8 to 8.4 per 100,000 population.^[9] Prevention strategies coincided with the development of a state-administered, no-fault, compulsory, transport insurance scheme. It was in the insurer's interest to reduce pay-outs by supporting legislative change and police enforcement. This economic driver was a key feature underpinning the more stringent compliance with and enforcement of road laws.

TRAUMA MANAGEMENT

Evidence from developed countries indicates that properly coordinated early rescue and retrieval systems together with appropriate early, in-hospital trauma management will prevent 15-30% of road crash deaths.^[10]

The first hour after a crash is crucial to a person's survival and in limiting the extent of injury. Evidence from the United States, Europe and Australasia indicates that there are three major contributors to death following road trauma. The two key physical causes are airway obstruction and blood loss. These two factors can not only quickly lead to death, but can also make resuscitation more difficult and lead to long-term complications if allowed to persist. The third major threat is delay to surgical treatment. This includes the provision of timely, adequate and appropriate emergency care at the accident site, expeditious delivery to hospital and appropriate treatment on arrival and during subsequent hospitalization. All stages of care provided require integration.

Prehospital care

In most countries the majority of trauma deaths occur outside of hospital. Following initial care at the crash scene, transport to hospital becomes a critical factor in trauma management. At least one-third of potentially preventable deaths occur prior to arrival at hospital and over half occur during the hospital reception and resuscitation phase of care.^[10]

Prehospital emergency care in India is only beginning to develop. Thirty per cent of emergency patients in India die before they reach a hospital. It is known that the first hour after injury is critical to both the survival of the injured and their injury outcome. Over 80% of accident victims do not get access to medical care within one hour of the incident.^[11] Long delays occur getting the injured to hospital. A recently published study from Mumbai noted that for severely injured patients, the time between

the injury and hospital admission averaged six hours.^[7]

Prehospital care at road crash sites in India is inconsistent and unreliable - with minimal, if any, medical intervention and long delays to hospital. There is a lack of state organized emergency ambulance services. Police numbers are signposted along state highways, but ambulance numbers are not. The vast majority of ambulances are used for inter-hospital transfer - not for primary response. Finding a suitable vehicle at the accident site is not easy. Persons who shift the victims are usually untrained members of the public. There is no linkage with hospital trauma services.^[12] Crash victims are often taken to the nearest hospital, regardless of the hospital's capabilities for dealing with trauma.

Within the large population centers in India, locally managed attempts to improve prehospital care have begun. However, the standard of medical care - specifically airway management, hemorrhage control and splinting - is provided at no more than a basic first-aid level. Whilst used to transport the injured, the auto-rickshaw is an inappropriate transport platform for seriously injured patients and the driver is unable to provide care whilst driving. Many patients are transported to hospital in the rear seats of taxis, reliant on friends providing care en route to hospital.

Rapid access to crash sites using strategically located emergency ambulance vehicles is achievable on national and state highways in India. For example, a recent Government of Kerala proposal for Trauma Care and Accident Management Units noted that if major emergency facilities were located at 80-100 km intervals along major roads, 95-98% of the population would have access to emergency care within one hour.^[13]

In the cities and villages where there are narrow and congested roads, motorcycle paramedics could provide a rapid response to crash scenes if required. Motorcycle paramedics based in built-up areas already exist in parts of India (e.g., Ludhiana, Punjab), Western Europe and Australasia.

The group of people most likely to be first at the scene of an accident should be targeted for a public awareness campaign. In most instances, motorists (or other passers by) will be the first on the accident scene. The public should be informed of their responsibilities and how to render a basic level of first-aid without fear of being held liable. Public first-aid posters should be displayed prominently on buses, along with public prevention campaign posters targeting, for example, helmet wearing and safer driving.

Commercial vehicles and bus operators should be encouraged to carry a comprehensive first-aid kit in order to provide immediate response to injuries, pending

professional assistance. A goal should be that a current first-aid certificate is a requirement for licensing.

Appropriately equipped (with staff trained for effective trauma response) ambulance services should continue to be developed. Ideal staffing for each ambulance is a driver and one or two attendants, with the attendants undergoing a certified life support program to a Basic Emergency Medical Technician standard (airway management, suction, oxygen administration, splinting, wound compression and hemorrhage control).

Hospital reception and resuscitation

The published literature related to trauma resuscitation in India is scant. Although well established in North America, the United Kingdom and Australasia, the development of Emergency Medicine as a recognized specialty has not yet occurred in India.

Organized trauma reception and resuscitation is difficult at many hospitals in India. There is often no warning of the pending arrival of major trauma patients and therefore no preparation. Attendance to a trauma patient is often delayed. Triage at hospital can be ineffectual or performed by non-clinical staff. In most Indian hospitals there is no trauma team or callout and no interdisciplinary approach to trauma reception. There is a single system approach to care, which is problematic when dealing with severely injured road crash patients who have multi-system injuries.

Few hospitals have dedicated equipped space for major trauma assessment and resuscitation. Senior surgical, emergency or anaesthetic presence in the setting of the initial trauma management is uncommon.

As previously mentioned, the lack of an effective trauma triage system delays the care of trauma patients. Triage guidelines need to be implemented to improve the trauma resuscitation process. A designated, trained triage nurse can categorize patients according to their level of injury, transfer trauma patients to an appropriate area and notify medical staff.

It is difficult to quantify how much the lack of organized and consistent hospital reception and resuscitation contributes adversely to patient outcome. However, a sentinel study based on autopsy data of road traffic fatalities in South Delhi in 1989 demonstrated that 64% of deaths were preventable or potentially preventable. The majority of preventable deaths resulted from a failure to diagnose or treat a life-threatening injury following arrival at hospital. Adherence to established principles in the hospital management of hemorrhage could have saved 70% of preventable deaths.^[14]

Hospital in-patient care

The post resuscitation care received in hospital is usually

co-ordinated by anaesthetists and surgical staff. Organized State Trauma Registries or data collection systems do not exist, making objective assessment difficult.

Representative studies reviewing injury outcomes have been published in the Indian medical literature. A study from a major hospital in Lucknow published in 2004^[15] used TRISS analysis^[16-18] to review trauma mortality. The authors compared patients' outcome to an international norm and then comparing predicted survival to actual survival. The details of the patients were recorded and the patients were followed until discharge or death during a six-week period. The mortality rate was 31.4%. TRISS methodology was applied to 88.6% of patients. All survivors were identified by TRISS methodology as likely to survive. Seventy-six per cent of trauma deaths during the study period were considered unexpected deaths by the TRISS methodology. The reasons for the unexpected deaths were septicemia, mannitol nephrotoxicity, aspiration and a direct result of the injury - especially in patients with burns. The authors concluded that although their hospital was the major trauma referral centre in the region, there was a high rate of unexpected deaths and the care provided to trauma patients needed to be improved.

A prospective study from a major trauma hospital in Mumbai published in 2004 analyzed the care and outcome of 1074 severely injured patients.^[7] The vast majority (82%) of all the cases in this study had no prehospital care. There is no formal Emergency Medical System in Mumbai, much like the rest of India. The police, fire brigade, individual initiatives, private ambulances and nongovernment organizations provided some prehospital care to the injured. There was no central coordination for trauma patients. The average age of the patients was 31 years and the commonest cause of injury was road traffic crashes. Using TRISS analysis the authors noted an observed mortality of 21.26% compared to a predicted mortality of 10.89%. The authors concluded that the injured in India were found to be older, the injuries more severe and the patient outcomes poorer with significantly more deaths than predicted.

To address the prehospital phase of care, activities to reduce accidents and the development of patient transport and ambulance services for trauma are a high priority.

For the hospital phase of care, the establishment of Tertiary Trauma Centers; increasing staff numbers and experience at Trauma Centers; training staff in trauma reception and resuscitation; supplying adequate equipment and an adequate supply of drugs to Trauma Centers and developing computerized data collection and record-keeping are required. These major teaching

hospitals need to be developed to form the hub of an integrated trauma system - providing 24-hour trauma reception teams, on-site neurosurgery, cardiothoracic surgery, intensive care and other specialist resources to deliver definitive care to the majority of India's major trauma caseload through primary triage from the accident scene or following secondary, inter-hospital transfer. Caseload concentration facilitates the development of a core group of surgeons, anesthetists and nurses who consistently manage large trauma volumes. Level 1 Centers are required to develop the resources and expertise to deliver leadership and support to the trauma system as a whole.

TRAUMA SYSTEM DEVELOPMENT

The evolving burden of injury has prompted the call for the development of organized Trauma Systems in India.^[19,20] A 'Trauma System' comprises an integrated, protocol-driven system of care which monitors and addresses prevention, notification, prehospital care, hospital reception and resuscitation, surgical care, in-hospital care and rehabilitation.

Optimal care of trauma patients requires an organized approach that recognizes the complexity and time-critical nature of major injuries. The concept of modern trauma systems originated from experiences with the management of soldiers injured in the Korean and Vietnam Wars - when evacuation by helicopter and refined prehospital care enabled rapid transport of patients to definitive surgical care centers and greatly reduced military casualty deaths.^[21,22] This encouraged the development of a landmark statewide system for treatment of civilian motor vehicle crash victims in Illinois in the early 1970s.^[23,24]

There is substantial evidence to support the concept that the timely delivery of seriously injured patients to centers experienced in the management of major trauma optimizes outcome. Implementation of a trauma system in Orange County, California improved the quality of trauma care delivered, and the proportion of deaths judged to be potentially preventable decreased.^[25] In Oregon, trauma system development led to an increased proportion of trauma patients treated at Level 1 trauma centers and substantially improved the survival rate.^[26] In San Diego a preventable death rate of 22% in 1984 fell to 2% after trauma system implementation^[27] and studies from New York State demonstrated a significant decrease in region-wide trauma mortality after system development.^[28] By March 2003, 35 US states had implemented a trauma system.

Although in India there is no national lead agency to coordinate various components of a trauma system,^[29] individual States have the opportunity to correct the almost complete lack of organized trauma care - and to

address the lack of appropriate health infrastructure - through the formulation and adoption of State Trauma Systems.

As previously indicated, evidence indicates that people with life-threatening - but potentially treatable - injuries are up to six times more likely to die in a country with no organized trauma system than in one with an organized, resourced trauma system.

Road crashes are a significant risk to the lives of all road users. Trauma does not discriminate. Effective trauma care demands immediate responses from trained emergency nursing, medical and technical staff. Trauma Systems have been developed to improve outcomes. However, the development of a comprehensive trauma care system is expensive. A constant concern is ‘...how can you indiscriminately treat first and recoup costs later..?’

A comprehensive review of the requirements and establishment of a State Trauma System can be found in a recently published article in *Injury*.^[30] The strategic principle of “the right patient to the right hospital in the shortest time” provided the basis for the plan. The article reviews the designation of specific hospitals of various levels to care for trauma patients; the concentration of trauma expertise at these centers; integration and coordination between the service providers; development of agreed triage and transfer protocols and improved education, training and research programs. A statewide major trauma database was established to enable system monitoring and facilitate further enhancements. This experience with the development of an integrated trauma system should aid in the development of Indian State Trauma Systems.

There are two key requirements for the establishment of State ‘Trauma Systems’.

The first requirement is policy development which recognizes the socio-economic burden of injury and commits governing institutions to reform present, inadequate systems of care. The requirement for policy development has already been stressed by the World Health Organization^[1,2] and needs to be continually stressed by interested parties - including surgical and associated medical groups who shoulder the burden of care.

The second key requirement is funding. An ongoing, guaranteed funding stream is crucial to Trauma System development.

FUNDING FOR TRAUMA SYSTEMS

Trauma care is expensive. It has been shown that trauma mortality is inversely proportional to a country’s per

capita gross national product.^[3,31] However, successful Trauma Systems rely on equity of access, with patients triaged on the basis of injury rather than their capacity to pay.

The lack of guaranteed, recurrent funding is the major threat to a State Trauma System establishing - and then continuing. By the mid-1990s 100 trauma centers had closed in the United States of America. The primary reason was financial loss from treating uninsured patients.^[32]

The authors recommend the establishment of no-fault, compulsory, third party insurance schemes linked to vehicle registration or alternatively as part of an annual ‘road tax’. The scheme would cover the prehospital and initial hospital and medical costs of all persons injured by a registered vehicle in a transport accident on a no-fault basis (drivers, passengers and pedestrians). It would not remove the common law rights for pecuniary loss and pain and suffering for the seriously injured. There would be oversight of medical excess and mandatory police reporting to reduce “frivolous” claims. Property damage car insurance would still be provided by private insurance companies.

The scheme is based on the Transport Accident Commission (TAC) which operates in Victoria, Australia. However, this latter scheme also provides long-term care for clients with major injuries and common law liability for clients who have a serious injury. These are the most significant areas of liability covered by the latter scheme but are not recommended initially.

Under the Victorian scheme US\$70,000,000 per annum covers road rescue, ambulance, acute hospital and medical costs of those persons injured by registered vehicles on the roads. This equates to US\$22 per annum per registered vehicle. The premium is collected automatically as part of an annual, vehicle registration process. This guarantees that the premium is collected and eliminates the need to “market” insurance. The TAC’s premium is based on 23 vehicle classes (passenger, goods, motorcycles, other) with smaller vehicles paying cheaper premiums. Geographic risk zones (Melbourne, surrounding areas, rural) are also loaded into the premium. Similar systems operate in other Australian states and jurisdictions.

A prepaid scheme guarantees prompt payment of hospital and medical costs, funding of infrastructure that can then be used for all trauma/emergency cases, the development of trauma registries for data collection, improved staffing and careers in trauma care - and improved patient outcomes. Guaranteed prompt payment of medical and hospital costs encourages clinicians who wish to devote their careers to trauma care and provides them with the infrastructure required.

Linked to this would be the development of appropriate training and India-specific education schemes, such as the Primary Trauma Care course conducted by the World Federation of Societies of Anesthetists or the National Trauma Management Course (NTMC) run by the Academy of Traumatology (India) in association with the International Association for Surgery of Trauma and Surgical Intensive Care.

A statutory authority or equivalent, would administer the scheme which would fund the costs of initial medical care on a no-fault principle. A no-fault scheme guarantees payment for care from the statutory authority irrespective of who is at fault and encourages immediate hospital care and surgical intervention for those who require it. For example, in Kerala there are an estimated 50,000 injured in accidents each year, at a healthcare cost of Rs. 80,00,00,000 or US\$ 20,000,000 per annum.^[5] In 2003 there were 2,500,000 registered vehicles in Kerala, implying an average Rs. 450 per annum per vehicle surcharge (US \$10) which could then be pooled to cover the scheme. Administrative costs need to be determined and a formal scoping study would need to be undertaken to accurately determine the costs associated with collection, infrastructure funding and medical and hospital care.

Therefore, the development of state-based, no-fault insurance schemes linked to the State health, police and road tax collection systems that currently exist in India, is recommended. These will have the capacity to reduce mortality rates and improve outcomes and will be propelled by a strong economic incentive to reduce the insurers' outgoing expenses by reducing the incidence of road trauma. The additional income then received will be appropriately spent on developing the medical and policing infrastructure required.

RESEARCH

There has been significant research in trauma over the last 20 years. Although many issues are universal, some findings are more relevant to the demography from which they are derived. This is demonstrated, for example, by the differences in the delivery of rural trauma care and the care delivered in densely populated urban environments or the differences in systems dealing with largely penetrating trauma compared to those systems that deal with predominantly blunt trauma. Each Indian State will need to mould the previously described generic principles to their own demographic.

Clinical research is commonly produced by practitioners in the particular field. Funding which fosters career development in the care of the injured will have a lasting benefit by generating systems improvement through research.

CONCLUSION

Road trauma in India is a significant societal burden which requires urgent attention. The death rate would be reduced with better organized systems of trauma care. A reduction of the road toll is dependent on state authorities introducing systems that fund accident prevention and the organized care of the injured.

Emergency and trauma care should not be considered as a luxury for rich countries or rich individuals in poor countries.^[33] The goal of an effective Trauma System should be to provide universal emergency care with equity of access. The belief that trauma care cannot be cost-effective in low-income settings needs to be refuted. Accidents occur everywhere and consume resources regardless of whether there are systems capable of achieving good outcomes. Better planning will result in cost-effective improvements in patient outcomes. However, without the development of protected and guaranteed funding schemes, Trauma System development in India will fail.

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