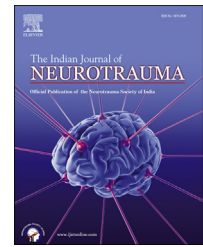


Available online at www.sciencedirect.com

SciVerse ScienceDirect

journal homepage: www.elsevier.com/locate/ijnt

Review Article

A critical appraisal of neurotrauma and neurocritical care perspectives of traumatic brain injuries in Indian scenario

Amit Agrawal*

Professor of Neurosurgery, Department of Neurosurgery, Narayana Medical College Hospital, Chinthareddypalem, Nellore 524003, Andhra Pradesh, India

ARTICLE INFO

Article history:

Received 19 February 2013

Accepted 12 May 2013

Available online 2 June 2013

Keywords:

Rural India

Traumatic brain injury

Neurotrauma

Neurocritical care

ABSTRACT

India and other developing countries face the major challenges of prevention, pre-hospital care, and rehabilitation in their rapidly changing environments to reduce the burden of traumatic brain injuries. Over the years the number of Neurosurgery centers has increased from the original three centers at Vellore, Chennai and Mumbai to many adequately equipped units, distributed in different corners of the country. The development of Neurosurgery in India has almost paralleled the achievements of the country and is now at par with the best of such services available in the world. This study focuses principally in the incidence, causation, management and impact of head injury and discusses the role of emergency physicians and neurosurgeons upcoming neuro-trauma and neuro-critical care facilities for a better outcome.

Copyright © 2013, Neurotrauma Society of India. All rights reserved.

1. Introduction

The development of Neurosurgery in India has almost paralleled the achievements of the country and is now at par with the best of such services available in the world.^{1–7} Over the years the number of Neurosurgery centers has increased from the original three centers at Vellore, Chennai and Mumbai to many adequately equipped units, distributed in different corners of the country.^{3,4} Most of the neurosurgical centers of excellence are based in the major metropolitan cities of the country and the access to these services is easier than before, still the total number of neurosurgeons outside major cities is inadequate even to provide uniform minimum basic neurosurgical facilities.^{3,4} India and other developing countries face the major challenges of prevention, pre-hospital care, and

rehabilitation in their rapidly changing environments to reduce the burden of TBIs. This study focuses principally in the incidence, causation, management and impact of head injury and discuss the role of emergency physicians and neurosurgeons that may help in practical organization of upcoming neurotrauma and neurocritical care facilities for a better outcome.

2. The road ahead

India is in the rapid transition from predominantly country agro-economic to industrial explosion. As a result of socio-economic growth, the most common mode of transportation in rural India is bicycle and motorbike, which increases the

* Tel.: +91 8096410032 (mobile).

E-mail addresses: dramitagrawal@gmail.com, dramit_in@yahoo.com.

0973-0508/\$ – see front matter Copyright © 2013, Neurotrauma Society of India. All rights reserved.

<http://dx.doi.org/10.1016/j.ijnt.2013.05.006>

risk of injuries. Trauma because of animal injuries horses, buffalo, cow, and bull is almost exclusively seen in rural area, as animals are being used for dairy and poultry purposes and for help in agriculture fields. India is undergoing major economic and demographic transition coupled with increasing urbanization and motorization. In India, 11% of deaths due to non-communicable diseases are due to injuries and 78% of injury deaths are due to road traffic accidents.⁸ In 2005, road traffic injuries resulted in the death of an estimated 110,000 persons, 2.5 million hospitalizations, 8–9 million minor injuries and economic losses to the tune of 3% of the gross domestic product (GDP) in India. Road traffic injuries are the leading cause (60%) of TBIs followed by falls (20%–25%) and violence (10%).⁹ Emergencies and accidents are commonplace in all parts of India and about 20% of all emergency-related visits are related to trauma.¹⁰ The World Health Organization (WHO) has projected that by 2020 road crashes will be a major killer in India, accounting for 546,000 deaths.¹¹

3. The burden: tip of the iceberg

Head injury is a major health problem all over the world and many studies report demography and outcome in TBI patients in Indian population.^{8,12} Minor head injuries, form the bulk of head injuries ranging from 80 to 90%. It amounts to 800,000 (minor) head injuries in India per year. More than 50% minor head injury cases continue to have problems lasting months or years.¹³ Severe head injury continues to be a nightmare due to the associated high mortality, morbidity and contributes immensely to socioeconomic losses in India and other developing countries.¹⁴ Many of the facts about traumatic brain injuries are well recognized including all over the world including in India i.e. TBI a major role in over 50% of cases, remains the leading cause of death in the population below 45 years of age, common in male patients, most of the injuries were vehicular injuries and the third most common cause of death loss of life and productivity is on the rise.^{8,15–17} Injuries are the 7th leading cause of mortality in India and 78% of these deaths are due to RTI alone.¹⁸ RTI are the leading cause of TBI in India accounting for 45–60% of TBI, and falls account for 20–30% of TBI, paralleling the findings from the Global Burden of Disease Study. Conservative estimates from India indicate that nearly 1.6 million individuals will sustain TBI and seek hospital care annually.¹³ Many studies highlight the inescapable facts that TBIs are on the rise, unsafe traffic environment, poor road infrastructure and encroachments that restrict safe areas for pedestrians; lack of safety engineering measures; traffic mix and an increasing number of motorized vehicles; unsafe driving behavior and lack of valid or fake driving licenses increase the risk of road crashes and public awareness campaigns and legislation can make a difference in reducing the number of head injuries.^{8,14,15,17,19–22} Alcohol consumption is known to be a major contributing factor for the occurrence of TBIs in both developed and developing countries and alcohol involvement is known to be present among 15%–20% of TBIs at the time of injury.⁹ Alcohol consumption can influence

diagnosis, management and recovery from TBIs, subsequent to injury occurrence.²⁰

4. The ground reality

Absence of reliable and quality information could be one of the reasons for the lack of initiatives on better road safety measures. The existing data with the police, hospitals, insurance, and legal sectors is disintegrated and needs major revamping. The Integrated Disease Surveillance Project of the Ministry of Health and Family Welfare recognizing this problem proposes to include the injury module as an additional component. There is, however, a need to develop and test a model for surveillance of road traffic injuries for inclusion in the health information system.⁸ Adequacy of sample size in outcome studies of head injury has been very much debated. In a recent meta-analysis of randomized controlled trials in head injury, the average number of patients per trial was found to be only 82 with no trend toward larger trial size over time. Many of the earlier studies are under powered to be able to provide reliable information on predictive factors of outcome following head injury.^{12,17} Despite the gaps in reporting of fatalities in road traffic crashes in these data sources, they provide insights into the magnitude and nature of deaths resulting from such crashes.¹⁶ The available data have limitations and there is a need for strengthening the road traffic crash surveillance system that could then form the basis for planning effective intervention strategies to improve road safety.¹⁶ A more uniform collection of data in a larger group of patients is necessary to establish an Indian database of operated head injuries. Such a database would facilitate multivariate analysis of risk factors to identify the independent predictors of outcome in operated head injured patients, and help to plan effective treatment strategies.¹²

5. Why it is important?

Head injuries are amongst the most common types of trauma seen in developing as well as developed countries. Minor head injuries in turn, form the bulk of these head injuries.^{23–25} A typical review of head injured patients admitted to a neurosurgical service found that 5% were 'severe' (GCS score <8), 11% were 'moderate' (GCS score 8–12), and 84% were 'minor' (GCS score 13–15).²⁴ It has been well recognized that mortality and morbidity tend to decrease in centers of excellence and effective implementation of preventive measures and wider availability of regional trauma systems over the last two decades have reduced the incidence rate and mortality associated with head and spinal cord injuries in developed countries.²³ The increased exposure to risk factors coupled with health systems that are often not able to provide adequate treatment and rehabilitation services to TBI patients, creates a 'double risk'. The economic consequences of TBI are reported to be enormous, and yet estimates of the cost of TBI within Asia could not be found in the literature. Given the preventable nature of TBI, it is important to elucidate the true burden of disease in Asia in order to tailor specific

prevention programs aimed at alleviating this increasing epidemic.²⁶

6. How to provide care?

Trauma care is in early stages of development, the budget for primary and secondary trauma care is grossly inadequate, health functionaries are unskilled, and disparities exist in states in developing countries. Teaching, nonteaching, and corporate hospitals are the major providers of secondary and tertiary health care in cities. So far, no attempt has been made to include these resources in the trauma care system where appropriate.²³ A strategy for integrated, coordinated trauma care and injury prevention activities needs to be developed in developing countries.^{9,14}

7. Pre-hospital care

The impact of traumatic brain injury (TBI) on patients, families, and society is tremendous, and management to lessen its effect starts at the injury site and in the pre-hospital stage.²⁷ Considerable good may be accomplished by ensuring that victims receive life-sustaining care within a few minutes of injury.²⁸ Those who are provided first aid at or near the injury site, transported early to a definitive hospital for management, reached a definitive hospital directly on their own or after the first medical contact have better survival and outcome. Over 80% of accident victims do not achieve access to medical care within 1 h of the incident.²⁹ Without the use of ambulances, bystanders usually perform prehospital care, including patient transport.³⁰ Although ambulances are often used more for inter-hospital transports and non-emergency calls, these are often little more than transport vehicles.³¹

8. Neurocritical care in India

Emergencies and accidents are commonplace in all parts of India and about 20% of all emergency-related visits are related to trauma.¹⁰ The World Health Organization (WHO) has projected that by 2020 road crashes will be a major killer in India, accounting for 546,000 deaths.¹¹ Indian statistics though not available, but it has been proposed that the guidelines for the acute medical management of severe traumatic brain injury at the least should be comparable with western literature.^{32,33} Trauma care in India is primarily provided by urban based teaching, non-teaching and corporate hospitals and these resources are not integrated into a trauma care system.^{31,34–37} Recent studies and an extensive review of the literature illustrate a nearly 15%–30% reduction in deaths in different parts of the world due to better organization of overall trauma care at different levels.^{11,38} The most important is that “the principles of injury prevention and control, applies for ‘traumatic brain injuries’ also, as it is only a variant of injury with different nature, severity and outcome”.²¹ Basic areas of expertise for the management of TBI is no different from skill required by an emergency physician and include resuscitation, airway management, supervision of pre-hospital

systems, and the provision of care ranging from initial to definitive for the complete spectrum of injuries in all age groups.³⁹

9. Neurosurgical care in India

Definitive care for victims with traumatic brain injuries is offered by government hospitals, corporate hospitals, and by a number of small clinics.¹⁰ Private and corporate hospitals (mostly in large cities) are equipped with advanced diagnostic and imaging facilities, however these sites may lack multidisciplinary support and trained emergency physicians.³⁹ In an already short number of neurosurgeons, there are no dedicated trauma surgeons and very few designated trauma centers in India. Orthopedic surgeons lead the trauma response in 50% of facilities.⁴⁰ It is difficult to say that how many dedicated neurocritical care or neurotrauma centers are there in the country and typically, most of the “emergency care” in the hospitals in India is provided in areas known as emergency rooms or casualty or accident rooms.^{35,37,40} Need not to be emphasized that when the responsibility is not clearly defined and there is absence of defined roles amongst specialists, there is a risk that the clinical decisions are often delayed.⁴⁰ and it becomes very difficult to deliver quality, cost-effective care.

10. Neurocritical care and neurosurgeons

The problem is not only in India but also in many other countries whether developed or developing. Factors are many but the main reason is economics as the senior consultant neurosurgeon in a private corporate hospital makes at least ten times more money than a full-time dedicated professor of Neurosurgery in a teaching hospital. Hence, many of the neurosurgeons after acquiring professional experience prefer to work in larger centers.⁴¹ Another reason seems to be due to lack of proper environment and lack of encouragement and financial support for clinical and basic research. Although there is abundant clinical material in most teaching hospitals, but there is lack of proper facilities and financial support for research, documentation and publication.⁴¹

11. Traumatic brain injuries and rehabilitation

The rehabilitation physician plays a central role in the course of the patient’s recovery and rehabilitation in patients with TBI has been recognized as a subspecialty of neuro-rehabilitation with an increasing awareness of its important role in early management for all severities of injury.⁴² Survivors of the traumatic brain injuries can have multiple residual impairments and disabilities,^{42,43} however to date there exists a limited body of evidence to study the potential implications and patient outcomes after TBI rehabilitation measures.^{42,44} Comprehensive and wide-ranging interventions have been developed not only to improve the outcomes but also to reduce total rehabilitation charges.⁴⁴ Targeted interventions

to appropriately reduce length of stay without compromising functional gains need to be developed within TBI program structures.⁴⁴ It has been suggested that there is a need of future studies to evolve sophistication in order to attempt to measure the cost-effectiveness of each rehabilitation intervention through the entire continuum of TBI rehabilitation.⁴⁴

12. Systemic approach to build an effective system

Injury prevention and control is an intersectoral activity requiring inputs from different sectors including road transport, road engineering, health, education, and many others. It is best developed by a systems approach by integrating several components for each intervention. Outcome following trauma and health care access are important components in any health care planning.⁴⁵ Although it has been shown that formalized systems of trauma care are believed to improve outcomes in an urban setting,^{46,47} however there is little evidence that trauma system implementation has benefited populations in rural areas.^{47,48} To institute mechanisms to systematically collect, analyze, disseminate injury-related data from health and related sectors by establishing surveillance mechanisms and trauma registries to develop evidence-based understanding of problems and solutions with a focus on developing cost-effective and sustainable intervention policies and programs.

13. Limitations are positive

Although the limitations are risk but can be an advantage as it has been emphasized that the general level of skill and knowledge of neurosurgeons in the developing nations is probably very similar to their colleagues in the developed world. In some ways, it may be even better, because there may be certain problems peculiar and common in their countries and they may have more knowledge about their management. The paying capacity of the patients and the subsidizing power of the government are far less in the developing nations. This translates into very few funds for buying technology inside and outside the operating room and hence reliance mostly on the skill of doctors and nurses. This may be one reason why some of the health care professionals in developing countries acquire stronger clinical skills and innovate techniques for the diagnosis and treatment of neurosurgical disorders.⁴⁹

14. Conclusion

The scenario as currently evident in developing countries existed in highly industrialized countries of the world in the 1970s. A great ideological transformation has taken place since accidents once considered unpredictable, and therefore unavoidable, are no longer considered unavoidable. Our dream should be devoted to those who have died from neurotrauma, those who are handicapped, and those who are alive. There are many reasons Socio-economic-cultural but there are three kind of people those who are getting, those

who are not getting or those it is not optimum. The responsibility of filling the gap between the one who is getting and the one who is not getting lies with us although each country has its own requirements and they have to work hard on their existing resources and develop in their own way to meet these demands. If people or at least paramedics available in rural and remote places can give the correct first aid, the job of physicians, surgeons would become much easier and golden hour principle can be honored very well. These deficiencies in neurotrauma care cannot be mitigated overnight. The strides India is making in emergency and trauma care is encouraging, but will require a concerted effort by society and the medical community to achieve the goal of providing excellent emergency care to all. Opportunities could be created in some hospitals in Japan where they could be trained for a shorter period. This will make all the difference to surgical outcome.

Conflicts of interest

The author has none to declare.

REFERENCES

1. Bhagwati SN. Paediatric neurosurgery in India. *Child's Nerv Syst.* 1999;15:802–806.
2. Gass H. Emergence of neurosurgery in India. *J Neurol Sci.* 1967;5:71–78.
3. Karapurkar AP, Pandya SK. Neurosurgery in India. *Neurosurg Rev.* 1983;6:85–92.
4. Nadkarni TD, Goel A, Pandya SK. Neurosurgery in India. *J Postgrad Med.* 2002;48:332–335.
5. Ramamurthi B. Perspectives in international neurosurgery: neurosurgery in India. *Neurosurgery.* 1982;10:530–531.
6. Ramamurthi B, Lee KC, Fukushima T, Takakura K, Petty PG, Weinstein PR. International neurosurgery: neurosurgical training and practice in India, Korea, Japan, and Australasia. *Neurosurgery.* 1989;25:1003–1008.
7. Saunders M. Postgraduate training in neurology and neurosurgery at Vellore, India. *Br J Med Educ.* 1969;3:133–134.
8. Pathak A, Desania N, Verma R. *Profile of Road Traffic Accidents & Head Injury in Jaipur (Rajasthan)*; 2008.
9. Gururaj G. Road traffic deaths, injuries and disabilities in India: current scenario. *National Med J India.* 2008;21:14–20.
10. Ramanujam P, Aschkenasy M. Identifying the need for pre-hospital and emergency care in the developing world: a case study in Chennai, India. *JAPI*; 2007:55.
11. Peden M, Scurfield R, Sleet D, et al. *World Report on Road Traffic Injury Prevention.* Geneva: World Health Organization; 2004.
12. Basavaraj K, Venkatesh HK, Umamaheswara Rao GS. A prospective study of demography and outcome in operated head injuries. *Ind J Anaesth.* 2005;49:24–30.
13. Mahapatra AK, Agrawal D, Kumar R. Minor head injury. *Indian J Neurotrauma.* 2008;5:59–62.
14. Gururaj G. Epidemiology of traumatic brain injuries: Indian scenario. *Neurol Res.* 2002;24:24–28.
15. Bhole AM, Potode R, Agrawal A, Johrapurkar S. Demographic profile, clinical presentation, management options in cranio cerebral trauma: an experience of a rural hospital in Central India. *Pakistan J Med Sci.* 2007;23:724.

16. Dandona R, Mishra A. Deaths due to road traffic crashes in Hyderabad city in India: need for strengthening surveillance. *National Med J India*. 2004;17:74–79.
17. Rekha A, Choudhary M, Selvakumar K. Head injuries a study from Sri Ramachandra University, India. *Ind J Trauma Anaesth Crit Care*. 2008;9:723.
18. Organization WH. *The World Health Report 1999: Making a Difference*; 1999:26. As of July 2010.
19. Dash HH. Prehospital care of head injured patients. *Neurol India*. 2008;56:415–419.
20. Gururaj G. The effect of alcohol on incidence, pattern, severity and outcome from traumatic brain injury. *J Indian Med Assoc*. 2004;102:157–160. 163.
21. Gururaj G, Kolluri S. Problems and determinants of traumatic brain injuries in India. *Nimhans J*. 1999;17:407–422.
22. Sabhesan S, Natarajan M. Alcohol abuse and recovery after head injury. *Indian J Psychiatry*. 1987;29:143–148.
23. Kumar R, Mahapatra AK. The changing “epidemiology” of pediatric head injury and its impact on the daily clinical practice. *Child’s Nerv Sys*. 2009;25:813–823.
24. Miller JD. Minor, moderate and severe head injury. *Neurosurg Rev*. 1986;9:135–139.
25. Watson MR, Fenton GW, McClelland RJ, Lumsden J, Headley M, Rutherford WH. The post-concussional state: neurophysiological aspects. *British J Psychiatry*. 1995;167: 514–521.
26. Puvanachandra P, Hyder A. The burden of traumatic brain injury in Asia: a call for research. *Pak J Neurol Sci*. 2009;4: 27–32.
27. Bhatoe HS. Brain injury and prehospital care: reachable goals in India. *Indian J Neurotrauma*. 2009;6:5–10.
28. Mock C. Improving prehospital trauma care in rural areas of low-income countries. *J Trauma*. 2003;54:1197–1198.
29. Fitzgerald M, Dewan Y, O’Reilly G, Mathew J, McKenna C. India and the management of road crashes: towards a national trauma system. *Indian J Surg*. 2006;68:226–232.
30. PoSaw LL, Aggarwal P, Bernstein SL. Emergency medicine in the New Delhi area, India. *Annals of Emerg Med*. 1998;32:609–615.
31. Agrawal A, Galwankar S, Kapil V, et al. Epidemiology and clinical characteristics of traumatic brain injuries in a rural setting in Maharashtra, India. 2007–2009. *Int J Crit Illn Inj Sci*. 2012;2:167–171.
32. Adelson PD, Bratton SL, Carney NA, et al. Guidelines for the acute medical management of severe traumatic brain injury in infants, children, and adolescents. Chapter 19. The role of anti-seizure prophylaxis following severe pediatric traumatic brain injury. *Pediatr Crit Care Medx*. 2003;4:S72–S75.
33. Khilnani P. Guidelines for acute medical management of severe traumatic brain injury in infants and children. *Indian J Crit Care Med*. 2003;7:285.
34. Gupta A, Gupta E. Challenges in organizing trauma care systems in India. *Indian J Community Med*. 2009;34:75.
35. Joshipura M, Shah H, Patel P, Divatia P, Desai P. Trauma care systems in India. *Injury*. 2003;34:686–692.
36. Agrawal A, Joharapurkar SR, Golhar KB, Shahapurkar VV, Dwivedi S, Meghe A. Head injuries in a rural setup: challenges and potential solutions. *J Emerg Trauma Shock*. 2008;1:129–130.
37. Agrawal A, Kakani A, Baisakhiya N, Galwankar S, Dwivedi S, Pal R. Developing traumatic brain injury data bank: prospective study to understand the pattern of documentation and presentation. *Indian J Neurotrauma*. 2012;9:87–92.
38. Mock C. *Guidelines for Essential Trauma Care*. WHO; 2004.
39. Das AK, Gupta SB, Joshi SR, et al. White paper on academic emergency medicine in India: INDO-US Joint Working Group (JWG). *J Assoc Physicians India*. 2008;56:789–798.
40. Joshipura M, Shah H, Patel P, Divatia P. Trauma care systems in India – an overview. *Indian J Crit Care Med*. 2004;8:93.
41. Ramesh VG. Whither neurosurgical teaching? *Neurol India*. 2006;54:317–318.
42. Chua KS, Ng YS, Yap SG, Bok CW. *A Brief Review of Traumatic Brain Injury Rehabilitation*. vol. 36. Singapore: Annals of the Academy of Medicine; 2007:31–42.
43. Yen HL, Wong JT. *Rehabilitation for Traumatic Brain Injury in Children and Adolescents*. vol. 36. Singapore: Annals of the Academy of Medicine; 2007:62–66.
44. Chua KS, Earnest A, Chiong Y, Kong KH. Characteristics and correlates of rehabilitation charges during inpatient traumatic brain injury rehabilitation in Singapore. *J Rehabil Med*. 2010;42:27–34.
45. McGuffie AC, Graham CA, Beard D, et al. Scottish urban versus rural trauma outcome study. *J Trauma*. 2005;59:632–638.
46. Mullins RJ, Mann NC, Hedges JR, Worrall W, Jurkovich GJ. Preferential benefit of implementation of a statewide trauma system in one of two adjacent states. *J Trauma*. 1998;44:609–616. discussion 617.
47. Rogers FB, Osler TM, Shackford SR, Martin F, Healey M, Pilcher D. Population-based study of hospital trauma care in a rural state without a formal trauma system. *J Trauma*. 2001;50:409–413. discussion 414.
48. Clay Mann N, Mullins RJ, Hedges JR, Rowland D, Arthur M, Zechnich AD. Mortality among seriously injured patients treated in remote rural trauma centers before and after implementation of a statewide trauma system. *Med Care*. 2001;39:643–653.
49. Raja IA, Raja AI. Role of Japan in the future of neurosurgery in Asia. *Neurol Med Chir*. 2005;45:433–437.