# Traumatic Brain Injury Registry: Sharing the Pilot Study Experience to Foster a Multicenter Project on Traumatic Brain Injury Core Data

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## Abstract

**Background** Trauma registry (TR) has been globally recognized as one of the vital tool in bridging the gap of information. The concept of TR has been extended to traumatic brain injuries (TBIs) in our study.

**Objectives** Present study was conducted to identify core variables necessary to collect data on the sociodemographics, clinical courses, interventions, and outcomes of TBIs and to develop an electronic data entry interface (including web-based data record interface).

**Methods** A predesigned pro forma with guidelines to complete the questionnaire was used to collect the data maintaining uniformity and reproducibility. The details of

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TBI pilot study questionnaire and data collection procedure (which included emergency assessment, patient characterization, preclinical data, emergency room intervention details, intensive care unit management details, diagnosis, and follow-up) were structured indigenously.

**Results** A total of 402 patients were included in this study. The mean age was 37.34 ± 16.08 years (male 78.11% and female 21.89%) and fairly good amount of details were available for the majority of the variables. In addition to the previously described variables, many other variables are proposed to be added to the further study which include handedness (right/left/ambidexterity), primary caregiver—responsible for earning in family, management-related variables (hypothermia therapy, nutrition replacement, hyperventilation therapy, and seizure prophylaxis), and details of complications (hypotension episode, hypoxia episode, any infections, and deep vein thrombosis). Disability rating scale was being added to make data collection and follow-up more objective and comparable.

**Conclusion** We hope and believe that this study will provide a cost effective, yet comprehensive data collection system on different parameters encompassing TBIs including configuration of existing care in our country.

## Introduction

In this new millennium, noncommunicable diseases are rapidly growing in the developing world including India adding to the existing burden of communicable diseases.[1,2] Injuries have been accepted as major cause of mortality, morbidities, and disabilities with uncountable downstream economic loss.[3,4] Yet, injury care in India is at a nascent stage of development and a nationwide survey encompassing various facilities has documented significant deficiencies in current trauma management systems.[3–14] Accurate data are needed to evaluate clinical outcomes, therapeutic modalities, and quality of care in trauma.[15] Reliable estimates of the burden of road traffic injuries are an essential input for rational priority setting and a national estimate of the burden of injuries should be built by collating information from all existing information sources by appropriately correcting for source-specific shortcomings.[2,16] The available data in India have severe limitations as injury surveillance system needs reliable, accurate, and adequate data to improve road safety interventions.[17] The present study was conducted to identify the core variables to collect data on the demographics, clinical course, management, and outcome of traumatic brain injuries (TBIs) and to develop an electronic data entry interface (including web-based data entry interface) in a resource-limited setting.

## Materials and Methods

The current study is an exploratory study performed at the Narayana Medical College & Hospital, Nellore, Andhra Pradesh, India. Prospective data collection was done for all the diagnosed cases of TBI admitted during the study period (July 2014–December 2014), using a predesigned and pretested questionnaire. The data were collected in a predesigned pro forma and all efforts were made to complete the questionnaire to maintain the uniformity and reproducibility. The details of TBI pilot study questionnaire and data collection procedure (which included emergency assessment, patient characterization, preclinical data, emergency room intervention details, intensive care unit [ICU] management details, diagnosis, and follow-up) have been described in our previous studies.[9–12,18–20] Several variables are identified as an essential component for any trauma registry (TR) such as age, gender, residence, district hospital; date and time of injury and arrival; Glasgow coma scale score for head injuries (TBIs)[21]; category (blunt, burn, and penetrating); mechanism of injury; intent of trauma; pre-existing conditions; vital signs on arrival (blood pressure, heart rate, and respiratory rate); optimum investigations including roentgenogram, computed tomography (CT), laboratory tests, or ultrasound; procedures performed; date of first surgery; length of stay; discharge status (alive or dead); and Glasgow outcome scale[22] were included in the pro forma (►**Supplementary Appendix I** and ►**Supplementary Appendix II** [online only]).[23–27] The data were collected by trained nursing personnel under the supervision of emergency and neurosurgery consultants. Based on paper-based pro forma, simultaneously, electronic data entry interface was developed in FileMaker Pro Advanced 13 (Copyright 1994–2015, FileMaker, Inc; Santa Clara, California, United States) and Web-based data entry interface was developed using Drupal CMS (http://neuropractices.com/content/tbi-registry). This helped in on-screen display, easy data entry, and proved useful in maintaining uniformity especially in case of data collection from multiple centers. The web-based data entry interface has restricted access and can only be accessible to registered uses. All the measures were taken to mask the identity of the patients. Permission from

institutional ethics committee was sought for carrying out the study. Written informed consent was collected from the patients in compliance with regulations and guidelines following Helsinki declaration if they were conscious at the time of data collection. In other cases, legally authorized representatives were approached for consent, viz., from next of kin, or in case of minors or patients unable to give consent.

## Statistical Analysis

A common analysis and reporting plan was prepared and analysis of data was done using StatsDirect version 3.0.150 (StatsDirect statistical software, StatsDirect Ltd., Cheshire, WA, England; 2015; http://www.statsdirect.com), generating simple frequencies for nonnumeric variables and simple averages for numeric variables.

## Results

A total of 402 patients were included in the study. Mean age was 37.34 ± 16.08 years (male 78.11% and female 21.89%), majority was illiterate (46.52%) (►**Table 1**). Loss of consciousness (73.88%) with or without vomiting (48.51%) followed by bleeding from ear (39.55%) and nose (32.84%) was the common clinical presentations; rhinorrhea was not noted in this pilot study. In the analysis of body regions involved along with TBI, it was noted that injuries to the extremities (17.16%) were the most important comorbidities. However, injury to pelvic girdle was not associated with any of the cases in this series. In the conservative management apart from tetanus toxoid (70.90%), urinary catheter (61.69%) was the commonest intervention followed by administration of colloid (59.95%) and crystalloid (37.06%); 13.18% cases were put on ventilation; blood transfusion was needed by only two cases. Based on ICD-10, traumatic cerebral edema was the commonest diagnosis (35.32%) followed by concussion (30.10%) and traumatic subdural hemorrhage (18.66%) (►**Table 2**). After detail analysis, a revised variable list was obtained (►**Supplementary Appendix I** [online only]) and a revised paper pro forma and electronic data interface were designed (►**Supplementary Appendix II** [online only]). In addition to the previously described variables, many other variables are proposed to be added to the further study which include handedness (right/left/ambidexterity), primary caregiver—responsible for earning in family,[24,27] management-related variables (hypothermia therapy, nutrition replacement, hyperventilation therapy, and seizure prophylaxis), and details of complications (hypotension episode, hypoxia episode, any infections, and deep vein thrombosis).[23–26] Disability rating scale was being added to make data collection and follow-up more objective and comparable.[28]

**Table 1** Details of educational and employment status of the patients who sustained traumatic brain injury

| Education and employment status | Frequency | % |
|---|---|---|
| Illiterate | 187 | 46.5 |
| Farmer | 102 | 25.4 |
| Primary | 29 | 7.2 |
| Unknown | 14 | 3.5 |
| House wife | 12 | 3 |
| Student | 8 | 2 |
| Employee in service | 3 | 0.7 |
| Unemployed | 8 | 2 |
| Self-employee | 9 | 2.2 |
| Retired employee | 3 | 0.7 |
| Graduate | 3 | 0.7 |
| Laborer | 2 | 0.5 |
| Secondary | 11 | 2.7 |
| Postgraduate | 2 | 0.5 |
| Total | 393 | 97.8 |
| Missing system | 9 | 2.2 |
| Total | 402 | 100 |

## Discussion

Success of a National Trauma Registry depend on the cooperative efforts; a short training to existing system of health workers can improve the scenario[29–33] and needs to be cost effective also.[34] The burden from domestic and nondomestic injuries is increasing relentlessly worldwide, accounts for 16% and road traffic injuries as the 9th leading cause of the morbidity load globally; 5th in the developed world, whereas 10th in developing ones; most commonly affecting men in their productive age group.[18] Major trauma accounts for approximately 10% of the world's deaths.[3,35–39] Mortality from trauma in rural areas is increased because of delay in discovery of the victim or delay in accessing the trauma system.[40,41] The prevalence of trauma as a public health hazard in low-resource settings globally has been severely neglected.[42]

The majority of trauma research is epidemiological in nature and despite the extensive clinical trauma experience, literature shows limited clinical trauma research.[43] TR is a system of data collection that serves as a source of information for the evaluation of trauma care for a specific set of injured patients meeting well-defined inclusion criteria.[34,44,45] TRs are an integral part of outcome assessment tool in many developed trauma systems[45,46] and also have been recognized as one of the vital tool in filling the gap of injury information perpetually refining the internalization of injury care.[47] Yet, many countries with limited resources have been able to establish useful TRs.[44,48,49] Initiation and continuation of a TR in any developing country is a challenging task, though it is feasible with the potential to develop a nationwide database.[50]

TRs provide large longitudinal databases for analysis and policy improvement[51,52] and can be used to successfully study the prehospital triage and survival of major trauma

**Table 2** Details of clinical presentation, body regions involved, conservative management, and diagnosis (ICD-10) as a dichotomous variable

| Clinical presentation | Yes | % | No | % |
|---|---|---|---|---|
| Loss of consciousness | 297 | 73.88 | 105 | 26.12 |
| Vomiting | 195 | 48.51 | 207 | 51.49 |
| Nausea | 13 | 3.23 | 389 | 96.77 |
| Ear bleed | 159 | 39.55 | 243 | 60.45 |
| Nasal bleed | 132 | 32.84 | 270 | 67.16 |
| Oral bleed | 57 | 14.18 | 345 | 85.82 |
| Headache | 59 | 14.68 | 343 | 85.32 |
| Seizures | 29 | 7.21 | 373 | 92.79 |
| Rhinorrhea | 0 | 0.00 | 402 | 100.00 |
| Otorrhea | 5 | 1.24 | 397 | 98.76 |
| Posttraumatic amnesia | 22 | 5.47 | 380 | 94.53 |
| Details of body regions involved | | | | |
| Head | 402 | 100.00 | 0 | 0.00 |
| Neck | 11 | 2.74 | 391 | 97.26 |
| Thorax | 5 | 1.24 | 397 | 98.76 |
| Chest | 16 | 3.98 | 386 | 96.02 |
| Abdomen | 1 | 0.25 | 401 | 99.75 |
| Pelvic girdle | 0 | 0.00 | 402 | 100.00 |
| Extremities | 69 | 17.16 | 333 | 82.84 |
| Pelvic contents | 0 | 0.00 | 402 | 100.00 |
| Cervical spine body region | 2 | 0.50 | 400 | 99.50 |
| Thoracic spine body region | 2 | 0.50 | 400 | 99.50 |
| Lumbar spine body region | 1 | 0.25 | 401 | 99.75 |
| Details of conservative management | | | | |
| Urinary catheter | 248 | 61.69 | 154 | 38.31 |
| Nasogastric tube | 78 | 19.40 | 324 | 80.60 |
| Tetanus toxoid | 285 | 70.90 | 117 | 29.10 |
| Crystalloid | 149 | 37.06 | 253 | 62.94 |
| Colloid | 241 | 59.95 | 161 | 40.05 |
| Blood transfusion | 2 | 0.50 | 400 | 99.50 |
| Cervical collar | 16 | 3.98 | 386 | 96.02 |
| Cervical traction | 1 | 0.25 | 401 | 99.75 |
| Bed rest | 320 | 79.60 | 82 | 20.40 |
| Steroids | 3 | 0.75 | 399 | 99.25 |
| Ventilation | 53 | 13.18 | 349 | 86.82 |
| Details of diagnosis (based on ICD-10) | | | | |
| S02.0 Fracture of vault of skull | 20 | 4.98 | 382 | 95.02 |
| S02.1 Fracture of base of skull | 24 | 5.97 | 378 | 94.03 |
| S02.3 Fracture of the orbital floor | 14 | 3.48 | 388 | 96.52 |
| S02.7 Multiple fractures involving skull and facial bones | 6 | 1.49 | 396 | 98.51 |
| S02.8 Fractures of other skull and facial bones | 15 | 3.73 | 387 | 96.27 |
| S02.9 Fracture of skull and facial bones, part unspecified | 1 | 0.25 | 401 | 99.75 |
| S06.0 Concussion | 121 | 30.10 | 281 | 69.90 |
| S06.1 Traumatic cerebral edema | 142 | 35.32 | 260 | 64.68 |
| S06.2 Diffuse brain injury | 10 | 2.49 | 392 | 97.51 |
| S06.3 Focal brain injury | 2 | 0.50 | 400 | 99.50 |
| S06.4 Epidural hemorrhage | 45 | 11.19 | 357 | 88.81 |
| S06.5 Traumatic subdural hemorrhage | 75 | 18.66 | 327 | 81.34 |
| S06.6 Traumatic subarachnoid hemorrhage | 37 | 9.20 | 365 | 90.80 |

patients.[53] Global evidence supports an improved trauma care through the use of functionally active and well-organized TRs to improve the management and outcome of trauma patients.[45,46,54–56] Besides demographic information, TRs provide information risk factors and outcomes of injury in terms of death and disability with details of various levels of care system (emergency medical services, emergency department, operating room, ICU, ward, rehabilitation units, etc.)[44,56] In the absence of accurate routine medical record data or well-designed injury surveillance systems, it is a challenge to understand the problems and risk factors for types of trauma, design appropriate interventions to prevent and treat trauma, monitor the effectiveness of interventions, and provide information to policy makers.[57–59]

For successful establishment of a multicenter TR, user friendly data entry system and continuous data analysis are needed.[51] The use of the common trauma template has been shown feasible across international registries for the majority of the data variables,[60] though the datasets of existing TRs frequently lack compatible definitions of common data variables.[61–65] Further, uniformity in the outcome variables and injury scoring systems across international trauma institutions is mandatory to obviate challenges to compare quality of the health care systems.[60] Successful TRs will be resource and setting specific in design to improve trauma care and outcomes, prevention programs are developed, and capacity-building goals realized.[48] Analysis of a TR as early as 6 months can lead to useful information which has long-term effects on the progress of trauma research and prevention.[50] The German Society for Trauma Surgery has contributed outcome analysis in relation to the injury pattern.[66] TRs in developing settings are plausible tools for injury surveillance. Since "multiple injuries" is not a homogeneous diagnosis, TRs collect prospective data from bigger hinterland to provide valid

data.[67,68] Regional registries will also ensure auditing enhancing policy making for injury prevention and improving the quality of patient-centered care as no standard definition exist for documenting, reporting, and comparing data from severely injured trauma victims.[69,70]

## Strengths of the Study

The study provides operationalization approach in establishing trauma-based registry in India using web-based interface for recording essential epidemiological and clinical profile of patients with TBI in uniform manner. This is essential as properly documented information in the medical record is important to understand the mechanisms of injury, the clinical characteristics, and to postulate how many deaths were preventable. To the horizon of our knowledge, this study is the debut one that systematically collected data on indigenously mastered registry in India. Furthermore, team-based approach was used with paramedics managing most of the demographic, clinical, and investigation variable with expert consultation for data regarding CT scan, electrocardiogram, and follow-up of patient. This is notable as the emergency physicians if sensitized may use similar approach to generate countrywide robust TBI data.

## Limitations of the Study

The findings of this study are subject to some limitations. Some epidemiological and clinical information may have been underreported due to the lack of proper documentation on the medical records; examples of missing information include: alcohol use, type of road where the injury occurred, pedestrian status, occupancy in a vehicle status, and type of vehicle. There were discrepancy and duplication of data at many of the places. Our study also does not account for patients who sought care in other nearby health care facilities, died on site, died after the first 24 hours, or those who survived their injuries; therefore, the results of this study should be interpreted with caution as they may not be representative of all cases of TBI in our hinterland.

## Future Directions of the Study

Fairly good amount of details were available for the majority of the variables that enthused for the next phase of the study. This information can be used to develop preventive interventions, emergency medical response services, and clinical guidelines and to educate decision makers about the preventability of this public health problem.

## Conclusion

TR has been globally recognized as one of the vital tool in bridging the gap of information. This can help enhance quality of injury care by identifying gaps in the trauma management system and find out opportunities of improvements. In absence of any national database, the policy makers could not be well sensitized regarding the socioeconomic and health impact of injury. We hope and believe that this study will provide a cost effective, yet comprehensive data collection system on different parameters encompassing TBIs including configuration of present scenario of prehospital care in our country.

## References


1 Bhalla K, Harrison J, Abraham J, et al; Global Burden of Disease Injury Expert Group. Data sources for improving estimates of the global burden of injuries: call for contributors. PLoS Med 2009; 6(1):e1
2 Bhalla K, Naghavi M, Shahraz S, Bartels D, Murray CJ. Building national estimates of the burden of road traffic injuries in developing countries from all available data sources: Iran. Inj Prev 2009;15(3):150–156
3 Gururaj G. Epidemiology of traumatic brain injuries: Indian scenario. Neurol Res 2002;24(1):24–28
4 Gururaj G. Road traffic deaths, injuries and disabilities in India: current scenario. Natl Med J India 2008;21(1):14–20
5 Agrawal A, Galwankar S. What's new in emergencies, trauma and shock? Traumatic Brain Injury Research in India: getting shape, taking momentum. J Emerg Trauma Shock 2015;8(3): 129–130
6 Munivenkatappa A, Shukla DP, Devi BI, Kumarsamy AD, Bhat DI, Somanna S. Domestic animal-related neuro-trauma: an account, from a tertiary institute. J Neurosci Rural Pract 2013;4(1):19–23
7 Shekhar C, Gupta LN, Premsagar IC, Sinha M, Kishore J. An epidemiological study of traumatic brain injury cases in a trauma centre of New Delhi (India). J Emerg Trauma Shock 2015;8(3): 131–139
8 Agrawal A. Injury surveillance or trauma registry: need of hour and time to start. The Indian Journal of Neurotrauma 2011;8(1): 37–39
9 Agrawal A, Coronado VG, Bell JM, et al. Characteristics of patients who died from traumatic brain injury in two rural hospital emergency departments in Maharashtra, India, 2007-2009. Int J Crit Illn Inj Sci 2014;4(4):293–297
10 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(3): 167–171
11 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(2):87–92
12 Agrawal A, Prasad MV, Kumar SS, Subrahmanyan B, Harisha P, Malleswara Rao G. Developing a traumatic brain injury registry: lessons learned from difficulties. Romanian Neurosurgery 2014; 21(3):309–314
13 Gururaj G. The effect of alcohol on incidence, pattern, severity and outcome from traumatic brain injury. J Indian Med Assoc 2004;102(3):157–160, 163
14 Gururaj G. Alcohol and road traffic injuries in South Asia: challenges for prevention. J Coll Physicians Surg Pak 2004; 14(12):713–718
15 Wynn A, Wise M, Wright MJ, et al. Accuracy of administrative and trauma registry databases. J Trauma 2001;51(3):464–468
16 Joshipura MK. Trauma care in India: current scenario. World J Surg 2008;32(8):1613–1617
17 Dandona R, Mishra A. Deaths due to road traffic crashed in Hyderabad city in India: need for strengthening surveillance. Natl Med J India 2004;17(2):74–79

18 Pal R, Agarwal A, Galwankar S, et al. The 2014 Academic College of Emergency Experts in India's INDO-US Joint Working Group (JWG) White Paper on "Developing Trauma Sciences and Injury Care in India". Int J Crit Illn Inj Sci 2014;4(2):114–130

19 Prasad MV, Agrawal A, Kumar SS, Subrahmanyan B. Converting a paper proforma template to a user friendly electronic database to collect traumatic brain injury data. Romanian Neurosurgery 2014;21(4):435–445

20 Nakase-Richardson R, Sepehri A, Sherer M, Yablon SA, Evans C, Mani T. Classification schema of posttraumatic amnesia duration-based injury severity relative to 1-year outcome: analysis of individuals with moderate and severe traumatic brain injury. Arch Phys Med Rehabil 2009;90(1):17–19

21 Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. Lancet 1974;2(7872):81–84

22 Jennett B, Bond M. Assessment of outcome after severe brain damage. Lancet 1975;1(7905):480–484

23 Guidelines for the management of severe head injury. European Journal of Emergency Medicine (online). Available at: http://journals.lww.com/euro-emergencymed/Fulltext/1996/06000/Guidelines_for_the_management_of_severe_head.10.aspxhttp://journals.lww.com/euro-emergencymed/Citation/1996/06000/Guidelines_for_the_management_of_severe_head.10.aspx. Accessed: July 28, 2015

24 Traumatic Brain Injury Standards - NINDS Common Data Elements (online). Available at: http://www.commondataelements.ninds.nih.gov/tbi.aspx#tab=Data_Standards. Accessed: July 28, 2015

25 Badjatia N, Carney N, Crocco TJ, et al. Guidelines for prehospital management of traumatic brain injury 2nd edition. Prehosp Emerg Care 2008;12:S1–S52

26 Kochanek PM, Carney N, Adelson PD, et al; American Academy of Pediatrics-Section on Neurological Surgery; American Association of Neurological Surgeons/Congress of Neurological Surgeons; Child Neurology Society; European Society of Pediatric and Neonatal Intensive Care; Neurocritical Care Society; Pediatric Neurocritical Care Research Group; Society of Critical Care Medicine; Paediatric Intensive Care Society UK; Society for Neuroscience in Anesthesiology and Critical Care; World Federation of Pediatric Intensive and Critical Care Societies. Guidelines for the acute medical management of severe traumatic brain injury in infants, children, and adolescents—second edition. Pediatr Crit Care Med 2012;13 (Suppl 1):S1–S82

27 Kavosi Z, Jafari A, Hatam N, Enaami M. The economic burden of traumatic brain injury due to fatal traffic accidents in Shahid Rajaei Trauma Hospital, Shiraz, Iran. Arch Trauma Res 2015;4(1): e22594

28 Rappaport M, Hall KM, Hopkins K, Belleza T, Cope DN. Disability rating scale for severe head trauma: coma to community. Arch Phys Med Rehabil 1982;63(3):118–123

29 McLellan BA. A Canadian National Trauma Registry: the time is now. J Trauma 1997;42(5):763–768

30 Nafissi N, Saghafinia M, Balochi K. Improving trauma care in rural Iran by training existing treatment chains. Rural Remote Health 2008;8(4):881

31 Jahunlu HR, Husum H, Wisborg T. Mortality in land-mine accidents in Iran. Prehosp Disaster Med 2002;17(2):107–109

32 Andersson N, da Sousa CP, Paredes S. Social cost of land mines in four countries: Afghanistan, Bosnia, Cambodia, and Mozambique. BMJ 1995;311(7007):718–721

33 Ascherio A, Biellik R, Epstein A, et al. Deaths and injuries caused by land mines in Mozambique. Lancet 1995;346(8977): 721–724

34 Rutledge R. The goals, development, and use of trauma registries and trauma data sources in decision making in injury. Surg Clin North Am 1995;75(2):305–326

35 Søreide K. Epidemiology of major trauma. Br J Surg 2009;96(7): 697–698

36 Mathers C, Fat DM, Boerma J. The Global Burden of Disease: 2004 Update. Geneva: World Health Organization; 2008

37 Trunkey D. Initial treatment of patients with extensive trauma. N Engl J Med 1991;324(18):1259–1263

38 Pape HC, Oestern H, Leenen L, et al. Documentation of blunt trauma in Europe survey of the current status of documentation and appraisal of the value of standardization. Eur J Trauma 2000; 26(5):233–247

39 Schmidt U. The German trauma system: infrastructure and organization. Trauma Q 1999;14:227–231

40 Cooper A, Barlow B, Davidson L, Relethford J, O'Meara J, Mottley L. Epidemiology of pediatric trauma: importance of population-based statistics. J Pediatr Surg 1992;27(2):149–153, discussion 153–154

41 Vane DW, Shackford SR. Epidemiology of rural traumatic death in children: a population-based study. J Trauma 1995;38(6): 867–870

42 Bickler SW, Rode H. Surgical services for children in developing countries. Bull World Health Organ 2002;80(10):829–835

43 Eid HO, Lunsjo K, Torab FC, Abu-Zidan FM. Trauma research in the United Arab Emirates: reality and vision. Singapore Med J 2008; 49(10):827–830

44 Nwomeh BC, Lowell W, Kable R, Haley K, Ameh EA. History and development of trauma registry: lessons from developed to developing countries. World J Emerg Surg 2006;1:32

45 Moore L, Clark DE. The value of trauma registries. Injury 2008; 39(6):686–695

46 MacKenzie EJ, Rivara FP, Jurkovich GJ, et al. A national evaluation of the effect of trauma-center care on mortality. N Engl J Med 2006;354(4):366–378

47 Mehmood A, Razzak JA. Trauma registry—needs and challenges in developing countries. J Pak Med Assoc 2009;59(12): 807–808

48 Schultz CR, Ford HR, Cassidy LD, et al. Development of a hospital-based trauma registry in Haiti: an approach for improving injury surveillance in developing and resource-poor settings. J Trauma 2007;63(5):1143–1154

49 Sanidas EE, Valassiadou KE, Kafetzakis AG, et al. Organisation of a trauma registry in a regional Greek university hospital: the first two years experience. Eur J Surg 2000;166(1): 13–17

50 Shaban S, Ashour M, Bashir M, El-Ashaal Y, Branicki F, Abu-Zidan FM. The long term effects of early analysis of a trauma registry. World J Emerg Surg 2009;4:42

51 Shaban S, Eid HO, Barka E, Abu-Zidan FM. Towards a national trauma registry for the United Arab Emirates. BMC Res Notes 2010;3:187

52 Probst C, Paffrath T, Krettek C, Pape HC; Registry TGT. Comparative update on documentation of trauma in seven national registries. Eur J Trauma 2006;32(4):357–364

53 Sturms LM, Hoogeveen JM, Le Cessie S, et al. Prehospital triage and survival of major trauma patients in a Dutch regional trauma system: relevance of trauma registry. Langenbecks Arch Surg 2006;391(4):343–349

54 Sampalis JS, Lavoie A, Boukas S, et al. Trauma center designation: initial impact on trauma-related mortality. J Trauma 1995;39(2): 232–237, discussion 237–239

55 Shackford SR, Hollingworth-Fridlund P, Cooper GF, Eastman AB. The effect of regionalization upon the quality of trauma care as assessed by concurrent audit before and after institution of a trauma system: a preliminary report. J Trauma 1986;26(9): 812–820

56 Lucas CE, Buechter KJ, Coscia RL, et al. The effect of trauma program registry on reported mortality rates. J Trauma 2001; 51(6):1122–1126, discussion 1126–1127

57 Smith GS, Barss P. Unintentional injuries in developing countries: the epidemiology of a neglected problem. Epidemiol Rev 1991; 13:228–266

58 London JA, Mock CN, Quansah RE, Abantanga FA, Jurkovich GJ. Priorities for improving hospital-based trauma care in an African city. J Trauma 2001;51(4):747–753
59 Frerichs RR. Epidemiologic surveillance in developing countries. Annu Rev Public Health 1991;12:257–280
60 Ringdal KG, Lossius HM, Jones JM, et al; Utstein Trauma Data Collaborators. Collecting core data in severely injured patients using a consensus trauma template: an international multicentre study. Crit Care 2011;15(5):R237
61 Edwards A, Di Bartolomeo S, Chieregato A, et al. A comparison of European Trauma Registries. The first report from the EuroTARN Group. Resuscitation 2007;75(2):286–297
62 Garthe E. Overview of trauma registries in the United States. J AHIMA 1997;68(7):26, 28–32, quiz 33–34
63 Mann NC, Guice K, Cassidy L, Wright D, Koury J. Are statewide trauma registries comparable? Reaching for a national trauma dataset. Acad Emerg Med 2006;13(9):946–953
64 Owen JL, Bolenbaucher RM, Moore ML. Trauma registry databases: a comparison of data abstraction, interpretation, and entry at two level I trauma centers. J Trauma 1999;46(6): 1100–1104
65 Ringdal KG, Lossius HM; SCANTEM ad hoc group on Scandinavian MTOS and Trauma Registry. Feasibility of comparing core data from existing trauma registries in Scandinavia. Reaching for a Scandinavian major trauma outcome study (MTOS). Scand J Surg 2007;96(4):325–331
66 Lefering R, Paffrath T, Linker R, Bouillon B, Neugebauer EA; Deutsche Gesellschaft für Unfallchirurgie/German Society for Trauma Surgery. Head injury and outcome—what influence do concomitant injuries have? J Trauma 2008;65(5):1036–1043, discussion 1043–1044
67 Gennarelli TA, Champion HR, Copes WS, Sacco WJ. Comparison of mortality, morbidity, and severity of 59,713 head injured patients with 114,447 patients with extracranial injuries. J Trauma 1994;37(6):962–968
68 Champion HR, Copes WS, Sacco WJ, et al. The Major Trauma Outcome Study: establishing national norms for trauma care. J Trauma 1990;30(11):1356–1365
69 Thanni LO, Kehinde OA. Trauma at a Nigerian teaching hospital: pattern and documentation of presentation. Afr Health Sci 2006; 6(2):104–107
70 Ringdal KG, Coats TJ, Lefering R, et al; Utstein TCD expert panel. The Utstein template for uniform reporting of data following major trauma: a joint revision by SCANTEM, TARN, DGU-TR and RITG. Scand J Trauma Resusc Emerg Med 2008; 16:7