http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 8 (7): 995-1000, 2005
ISSN 1028-8880

NISS a Valuable Tool for Trauma Scoring on Autopsy

B.R. Sharma, Manisha Gupta and Sumedha Bangar
Department of Forensic Medicine and Toxicology, Government Medical College and Hospital, Chandigarh-160030, India

Abstract: A retrospective autopsy-based study conducted in correlation with the relevant clinical records and the reports from investigating agencies to analyze the suitability of Injury Severity Score (ISS) and New Injury Severity Score (NISS) in predicting the mortality of trauma victims. Four hundred and forty six autopsy reports of the victims of road traffic accidents were thoroughly studied and the external and internal injuries were assigned AIS coding. Based on this coding ISS and NISS scoring was done. On comparing both scoring systems it was found that ISS, satisfactorily correlates to the survival period among the trauma patients of multiple wounds but NISS was a better scoring system.

Key words: Road-traffic accidents, trauma scoring, Abbreviated Injury Scale (AIS), Injury Severity Score (ISS), New Injury Severity Score (NISS)

INTRODUCTION

Trauma deaths have taken an epidemic form the world-over. Vehicular accidents have emerged to be the major cause of trauma death among people below 50 years of age[1]. India, the former USSR and the USA have reported the largest number of traffic related fatalities among all nations[2]. Estimates suggest that there are 60 fatal accidents per 10,000 vehicles per year in India, compared to 2-3 fatal accidents per 10,000 vehicles per year in the developed countries[3]. In India, Goa (71%) tops the list of accident rate, followed by Daman and Diu (69%), Maharashtra (64%) and Delhi (61%)[4]. Road Traffic accidents account for 33.2% of total accidental deaths in India. National Crime Record Bureau Report[3] shows that one accidental death is reported in India every 1.9 min, with total figure at more than 270000 per year.

The development of valid and useful quality-improvement methods, comparisons of therapeutic modalities with the outcomes of trauma patients, collection of basic epidemiologic trauma data and effective use of pre-hospital and inter-hospital triage are major needs in the trauma care system. A prerequisite to meeting these needs is the uniform application of severity scales to the trauma patients. Current commonly used scales can be grouped according to the type of patient information on which they are based, such as physiologic measures, measures of anatomic damage and biochemical measures.

Physiologic injury scores take into consideration vital parameters like the pulse rata, respiratory rate, blood pressure etc. and obviously can not be applied to trauma scoring on autopsy. However, anatomic scoring system is a valuable tool for this purpose. The first attempt to classify injuries on the basis of severity was perhaps, made by DeHaven in early 1950s, when he created a scale to study light plane crash injuries[5,6] followed by the concept of the Abbreviated Injury Scale (AIS) in 1969 with an emphasis on blunt trauma associated with motor vehicle accidents[7]. Originally developed in 1971, as a collaborative effort by the American Medical Association, the American Association for Automotive medicine and the Society of Automotive Engineers, with assistance from consultants primarily from surgical subspecialties, it was at first focussed on impact injuries to aid in crash investigations. The AIS has been revised at least six times since the original 1971 version to introduce the severity value of different injuries. The 1985 version, AIS-85, introduced severity values for penetrating injuries and clinical terminology to describe thoracic, abdominal and vascular injuries and these severity values have been assigned to ICD-9-CM injury rubrics[8]. The latest revisions of AIS were made in 1990 (AIS-90). Presently, AIS is an internationally accepted classification of wounds by anatomic type and severity. It permits comparison of morphologically dissimilar wounds of similar severity in statistical applications involving multiple cases[9].

The ISS is virtually the only anatomical scoring system in use that correlates linearly with mortality, morbidity, hospital stay and other measures of severity[10]. The ISS for a subject derives from the three highest AIS

Correspondence Author: B.R. Sharma, Department of Forensic Medicine and Toxicology, Government Medical College and Hospital, Chandigarh-160030, India

scores for that subject and has been used as a retrospective predictor of mortality. However, it has been criticized for its failure to account for multiple severe injuries in the same body region[11,12]. It has been documented that any error in AIS scoring increases the ISS error, many different injury patterns can yield the same ISS score and injuries to different body regions are not weighted. The Anatomic Profile (AP) and a Severity Characterization of Trauma (ASCOT) were introduced to address these shortcomings, however, they offered only modest gains in predicting trauma mortality. Moreover, their computational complexity further hindered general acceptance as an alternative to the ISS. Osler *et al.*[13] proposed New Injury Severity Score (NISS) that takes into account the 3 most severe injuries (highest AIS score) irrespective of body region. This simple modification of the ISS was demonstrated to improve mortality prediction in trauma victims. A study by Brenneman *et al.*[12] in Canada evaluated ISS and NISS among patients with blunt trauma and concluded that NISS provides a more accurate prediction of short-term mortality. Thus, the present retrospective autopsy study was conducted to compare whether ISS or NISS is better in co-relation with the survival period in cases of trauma by autopsy method, since these scoring methods have been found valid for evaluating trauma care by many researchers[14-16].

MATERIALS AND METHODS

This retrospective study was conducted at Department of Forensic Medicine and Toxicology, Government Medical College and Hospital Chandigarh a Tertiary Care Center, catering to the health and medical needs of the city, having a population of over one million people and a referral center for the adjoining states of Punjab, Haryana and Himachal Pradesh. Duration of the study was four years, from January 2000 to December 2003. Victims of road- traffic accidents subjected to medicolegal autopsy, whose detailed history and case records were available, were the subjects of study. Unclaimed, decomposed or cases with doubtful history were excluded from the study. Trauma deaths resulting from vehicular accidents only were considered for the study on account of their prevalence and the presence of multiple injuries on the body.

To study the relationship between short-term survival period and the trauma scoring by ISS and NISS, the cases were divided into 3 categories as follows:

- Survival period of 1 to 6 h
- Survival period more than 6 h and upto 12 h
- Survival period ranging between 12 to 24 h

All the external injuries and the internal injuries to the organs of three main body cavities (cranium, thorax and abdomen), mentioned in the autopsy reports were carefully considered. The Abbreviated Injury Scale (AIS) of each injury was determined using Association for Advancement of Automobile Medicine 1990 protocol[17]. ISS and NISS scores were calculated on the basis of AIS-90. Other relevant parameters like age, sex, survival time, date and time of injury and medical interventions done were also recorded. The results were analyzed to find out the correlation between ISS, NISS and survival period by regression analysis.

RESULTS

Out of a total 11792 victims of Road Traffic Accidents reporting to the Emergency Wing at Government Medical College Hospital Chandigarh, 426 (3.61%) had a fatal outcome, whereas 234 (1.98%) sustained permanent disability of variable extents (Table 1).

Annual Breakup of medicolegal autopsies (Table 2) reveals a more or less uniform pattern of one-third unnatural deaths being due to vehicular accidents.

Age and gender distribution of fatal vehicular accident victims (Table 3) reveals that maximum number of cases (31.69%) were in the age group of 21-30 years, followed by 25.59% in the age group of 31 to 40 years. Minimum number of cases was seen in the age group 0-10 years (0.94%), followed by 6.34 and 7.98% in age groups 11 to 20 and above 60, respectively. The overall involvement of males was 69.01% as compared to 30.99% for females; with the male, female ratio being 2.3: 1.

Among the offending vehicles (Table 4), motorcycles outnumbered all other categories of vehicles claiming 24.88% victims of fatal accidents.

116 (27.23%) victims of Road Traffic Accidents died within one hour of the accident, either on the spot or during the process of shifting to the hospital or within a few minutes of arrival in the hospital. 99 (23.24%) survived for one to six hours, 16 (3.76%) for six to twelve hours and 32 (7.51%) for twelve to twenty four hours. Survival period of 3 days to 1 week was recorded in 68 (15.96%) cases, whereas 38 (8.92%) survived for more than one week (Table 5). Over all, 215 (51%) victims died within 6 hours of the accident, of which 116 (52.6%) victims died either on the spot or were declared brought dead to the hospital.

Ninety-three of the ninety-nine cases that died in one to six hours were found to have AIS of 5 to 6. They could be assigned the ISS of 36 to 75 whereas the NISS assigned to them was 66 to 75. Forty eight cases, of which, six had a survival period of one to six hours,

Table 1: Road traffic accidents reporting to the Government Medical College Hospital Chandigarh

	No. of accident cases reporting to casualty		No. of fatal accidents		No. of accidents causing disability		No. of non-fatal accidents	
Year	No.	%	No.	%	No.	%	No.	%
2000	2569	21.79	113	04.40	61	02.38	2395	93.23
2001	3012	25.54	94	03.12	63	02.09	2855	94.79
2002	2738	23.22	111	04.05	53	01.94	2574	94.01
2003	3473	29.45	108	03.11	61	01.76	3304	95.13
Total	11792	100	426	03.61	238	02.00	11128	94.37

Table 2: Annual breakup of fatal accident cases

				Males		Females	
Year	Total autopsies	No. of RTA	RTA (%)	No.	%	No.	%
2000	352	113	32.10	75	66.37	38	33.63
2001	372	94	25.27	63	67.02	31	32.98
2002	381	111	29.13	84	75.68	27	24.32
2003	369	108	29.27	72	66.67	36	33.33
Total	1474	426	28.90	294	69.01	132	30.99

Table 3: Age and gender distribution of cases

	Males		Females		Total	
Age group (years)	No.	%	No.	%	No.	%
0-10	03	01.02	01	00.76	04	00.94
11-20	19	06.46	08	06.06	27	06.34
21-30	90	30.61	45	34.09	135	31.69
31-40	75	25.51	34	25.76	109	25.59
41-50	55	18.71	21	15.90	76	17.85
51-60	28	09.52	13	09.85	41	09.62
> 61	24	08.16	10	07.58	34	07.98
Total	294	69.01	132	30.99	426	100

sixteen cases with a survival period of six to twelve hours and twenty six out of thirty two cases having a survival period of twelve to twenty four hours were assigned ISS of 16 to 65. The NISS assigned to the same cases was more precise ranging between 56 to 65. In six cases having a survival period of twelve to twenty four hours and the ISS<16 it was found that they could be assigned the NISS between 46 to 55 (Table 6).

The ISS and NISS were identical in 42 (28.57%) cases and discrepant in 105 (71.42%) cases. Patients with identical scores had longer survival period than the patients with discrepant scores. Focussing the analysis on the cases with a discrepancy between the two scores, we found that as the difference in scores increased, the survival period decreased significantly.

DISCUSSION

Bergvist *et al.*[18] felt the importance of relationship between injury scores and survival period. This information can help in giving priority in treatment, especially in countries where resources are limited. Again, this information can serve as a yardstick to measure the quality of care being provided by an institution for these types of cases. In its present form, the AIS codes injuries based on their anatomic site, nature and severity. All injuries are assigned a value ranging from 1 to 6 where 1 represents a minor injury, 2 moderate, 3 serious, 4 severe, 5 critical and 6 a fatal injury. The full AIS code for a given condition has seven numerals. The first numeral designates the body region, the second indicates the general type of anatomic structure, the next two specify the anatomic structure and the last following a period, is the severity score. For example, the code 5 4 18 24-3 represents a solitary liver laceration >3 cm deep with major duct involvement. The 5 indicates abdomen as the body region, the 4 in the second place indicates an organ, the 18 in places three and four indicate liver and the 24 in the fifth and sixth places indicate laceration >3 cm in depth, with major duct involvement. The 3 in the final place is the severity score assigned to this particular injury and specifies a serious injury.

The International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM)[19] injury codes listed in the hospital discharge summaries can be mapped to AIS values. However, the following limitations of the process, create strong disincentives for the use of mapping in institutional evaluations of trauma-patient outcome or in quality-assurance activities:

- For some ICD rubrics that can be associated with several AIS severity values, the assigned value is the one that occurs most frequently, which is not always the correct value.
- The mapping does not assign AIS score to some ICD rubrics (thus, the associated injury description must be coded by hand).
- Although users of the mapping must assume that ICD-9-CM codes have been accurately and consistently determined, substantial variability in ICD coding has in fact been documented.
- Coding quality may be affected by the fact that much discharge coding is done to enhance reimbursement rather than to ensure precision in documenting injuries.
- Discharge summaries are often limited in the number of ICD-9-CM diagnoses that may be recorded; in such cases, codes for serious injuries may be omitted.

Because the AIS assigns severities to the individual injuries, summary scores are needed to characterize the

Table 4: Victims of road traffic accident

	Total		Type of injury							
			Head injury		Chest injury		Abdomen injury		Others	
Type of road user	No.	%	No.	%	No.	%	No.	%	No.	%
Pedestrians	179	42.02	104	58.10	66	36.87	33	18.44	58	32.40
Motor-cyclists*	106	24.88	61	57.55	65	61.32	42	39.62	69	65.09
Cyclists	51	11.97	39	76.47	29	56.87	18	35.29	25	49.02
Bus passengers	29	06.81	11	37.93	18	62.07	08	27.59	19	65.52
Rest**	61	14.32	32	52.46	22	36.07	14	22.95	24	39.34
Total	426	100	247	57.98	200	46.95	115	27.00	195	45.78

*Both the drivers and the pillion rider, **Occupants of auto-rickshaws, cycle-rickshaws, cars, vans, trucks, tractors, etc.

Table 5: Percentage of survival period

Survival period	No.	%
S.D*./B.D.**/< 1 h	116	27.23
1-6 h	99	23.24
6-12 h	16	03.76
12-24 h	32	07.51
1-3 days	57	13.38
3 days-1 weak	68	15.96
>1 weak	38	08.92
Total	426	100

*S.D.: Spot death ** B.D: Brought dead

Table 6: Severity score vis-a-vis survival period

No. of cases	AIS	ISS	NISS	Survival period
93	5 to 6	36 to 75	66 to 75	1 to 6 h
48	3 to 5	16 to 65	56 to 65	6 to 12 h
06	2 to 4	<16	46 to 55	12 to 24 h

multiple injuries typically sustained by the trauma patient. To this end, The Injury Severity Scores (ISS) was developed to incorporate the concept that the combined effect of multiple wounds of lesser severity occurring in different body regions can have a lethal potential equal to that of a single wound of greater severity in a single body region. ISS scores are derived by adding the squares of the maximum AIS scores from the three most severely injured body regions. They have a ceiling of 75, which can be reached by totaling, for example, $5^2+5^2+5^2$ or by having a single AIS score of 6. The ISS has remained the standard anatomic measure of injury severity since its introduction over two decades ago[10]. Perhaps the most notable limitation of the ISS is that it excludes multiple injuries to a single body region by allowing only the most sever injury in each body region to be considered[20,21]. Moreover, when multiple body regions are injured, the ISS will ignore more sever injuries in one body region in favor of less sever injuries to another body region[20]. However, despite the limitations, anatomic injury scoring systems are readily applicable in coding autopsy findings and provide a powerful tool for the physician and for trauma research. Autopsy continuing to be the Gold Standard by which the physician's clinical diagnosis is, either confirmed, amended or refuted. It is the most reliable and accurate instrument for investigation of injuries.

The NISS is a simple but significant modification of the ISS[22]. By considering the three most sever injuries regardless of body region, it avoids many of the previously acknowledged limitations of the ISS. Furthermore, by preserving the AIS as the framework for injury severity scoring the NISS remains familiar with the researchers. Present study documented some potential advantages of NISS over the ISS, however, there are several reasons for caution. First, we used a relatively small sample size from one autopsy center over a short time interval of four years. Secondly, present study did not capture the distribution of specific injuries in trauma-victims in which the ISS and the NISS were discrepant. We are unable to comment on the body regions most responsible for discrepant scores even though such data may be crucial when considering the entire scoring system. Finally, the subjects of our study were only the victims of fatal vehicular accidents who survived for one to twelve hours and had critical and fatal injuries, the results may differ for other groups with lesser degree of injury. Brennaman *et al.*[12] who reported identical scores in 32% cases, also advocated that NISS was a better scoring system as compared to ISS.

Fundamentally, trauma outcome prediction is a multivariate problem. Researchers use multiple independent variables (e.g., age and injury severity) to predict the dependent variable (or outcome). In trauma severity scoring, mortality is the outcome that has elicited the most interest. Mortality is a dichotomous variable having only 2 possible values, death or survival. Although several methods are available, multiple logistic regression is the most popular approach when the outcome of interest is dichotomous. Indices of severity and audit criteria are of value in identifying aberrant outcomes or potential problems in patient care and in prompting remedial action. In this regard periodic review of the process and outcome of patient care, as recommended by the Joint Commission on Accreditation of Healthcare Organization (JCAHO) for quality improvement and utilization need be implemented by trauma services[23].

The crucial importance of autopsy in trauma research has been widely accepted[24]. Introduction of trauma scoring to postmortem examination will further enhance autopsy's prominent role and may help establish a common language for all aspects of fatal trauma research.

This kind of database would be a powerful device for quality assessment of trauma treatment. Numeric coding will also help in computerizing the autopsy findings and increasing the availability of data for population studies. The use of survival scoring system permits rapid identification of unexpected outcomes, allowing investigators to perform detailed reviews of particular cases to determine the reason for particular outcome. The scarcity of injury data on the estimated 50% of fatally injured persons who die at the scene of accident or in transit continues to represent a real information gap. Demographics and injury information on these victims, if it exists, is found only in autopsy reports. Lack of uniform system of death investigation sometimes renders this data incomplete and not easily accessible[25].

Methods of trauma scoring are fundamental to any system that engages in this type of research. Appropriate methods provide useful data for quality assurance and improvement and resource allocation. The most frequently used methods for scoring trauma rely on anatomic or physiologic measurements or a combination of the two. Anatomic scales score each organ injury separately and they are designed to characterize and rate all injuries. However these scales rely to a certain degree on retrospective data and are of limited use in initial assessment and triage in the field.

Among the pure anatomic scoring systems, NISS is reportedly a better system as compared to ISS in order to measure survival period as well as mortality. Another practical forensic utility of the study lies in the fact that it provides an objective criterion as to at what, median/ mean of NISS/ISS the injuries may be sufficient to have a fatal outcome. In order to accomplish the above reference values of mean/ median of NISS/ISS should be available for each type of traumatic death in a particular set up. We recommend that trauma scoring should become a definite component of clinical forensic medicine, trauma autopsies and of the quality assurance system in trauma centers. However, present study does not resolve the controversy between preserving the ISS or adopting the NISS as the new severity scoring system. It only highlights the need for further long-term outcome studies from different centers.

REFERENCES

1. Sharma, B.R., D. Harish and V. Sharma *et al.,* 2001. Road Traffic accidents-A demographic and topographic analysis. Med. Sci. Law, 41: 266-274.
2. Sahdev, P., M.J. Lacqua and B. Singh *et al.,* 1994. Road Traffic fatalities in Delhi: Causes, injury patterns and incidence of preventable deaths. Accid. Anal. Prev., 26 : 377-384.
3. National Crime Record Bureau: Accidental Death and Suicide in India, 1999 (2000). Ministry of Home Affairs, Govt. of India, New Delhi.
4. Murty, O.P., 1999. Traffic pollution and its effects on human. CME Monograph series-1. Proceedings of the National Workshop on Practical and Emergency Med. Toxicology-AIIMS 24-26 Feb., 1998, pp: 77-80.
5. DeHaven, H., 1952. The site, frequency and dangerousness of injury sustained by 800 survivors of light plane accidents. New York, Crash Injury Research, Department of Public Health and Prevention Medicine, Cornell University Medical College.
6. Ryan, G.A. and J.W. Gassett, 1968. A Quantitative Scale of Impact Injury. Publication CAL No. VT-1823-R34. Buffalo, Cornell Aeronautical Lat. Inc. Cornell University.
7. The Abbreviated Injury Scale-1985 Revision. Des Plaines, II, Association for the Advancement of Automotive Medicine.
8. MacKenzie, E.J., D.M. Steinwachs and B.S. Shankar, 1989. Classifying trauma severity based on hospital discharge diagnosis. Validation of an ICD-9-CM to AIS-85 conversion table. Med. Care, 27: 412.
9. Adams, V.I. and C. Carrubba, 1998. The Abbreviated Injury Scale-Application to autopsy data. Am. J. Forensic Med. Pathol., 19: 246-251.
10. Baker, S.P., B. O'Neill, W.J. Haddon and W.B. Long, 1974. The injury severity score: A method for discribing patients with multiple injuries and evaluating emergency case. J. Trauma, 14: 187-196.
11. Copes, W.S., H.R. Champion and W.J. Sacco *et al.* 1968. The injury severity score revisited. J. Trauma, 28: 69-77.
12. Brenneman, F.D., B.R. Boulonger and B.A. McLellan *et al.,* 1998. Measuring injury severity: Time for a change? J. Trauma Injury, Infection and Critical Care, 44: 580-584.
13. Osler, T., S.P. Baker and W. Long, 1997. NISS: The new injury severity score. In: 10th Annual Meeting of the Eastern Association for the Surgery of Trauma, Sanibel FL.
14. West, J.G., 1982. Validation of autopsy method for evaluating trauma case. Arch. Surg., 117: 1033-1035.
15. Okada, Y. and I. Ishiyama, 1987. Forensic usefulness of the injury severity score. Med. Sci. Law, 27: 214-217.
16. Kumar, B., G. Paul and A.K. Sharma, 1989. Injury Severity Score as a yardstick in assessing the severity and mortality of various abdomino-pelvic trauma hospitalized victims- a clinical vis-à-vis autopsy study. Med. Sci. Law, 29: 333-336.
17. Association for the Advancement of Automobile Medicine, 1990. The Abbreviated Injury Scale 1990 Revision.

18. Bergvist, D., H. Hedeline and G. Karlson *et al.*, 1983. Abdominal trauma and fatal outcome: Analysis of thirty-year studies. J. Trauma, 23: 499-502.
19. Commission of Professional Hospital, 1977. Activities: The International Classification of Diseases. 9th Revision, Clinical Modification. Ann Arbor, MI, Edwards Brothers.
20. Ostler, T., 1993. Injury Severity Scoring: Perspectives in development and future directions. Am. J. Surg., 165: 43S-51S.
21. Copes, W.S., H.R. Champion and W.J. Sacco *et al.*, 1990. Progress in characterizing anatomic injury. J. Trauma, 30: 1200-1207.
22. Osler, T., S.P. Baker and W. Long, 1997. A modification of the injury severity scores that both improves accuracy and simplifies scoring. J. Trauma, 43: 922-925.
23. Southard, P., 1993. Trauma Economics: Suggestions for decreasing the cost of trauma care. J. Emerg. Nurs., 19: 262.
24. Sharma, B.R., 2003. Clinical forensic medicine-management of crime victims from trauma to trial. J. Clinical Forensic Med., 10: 267-273.
25. Riddick, L., W. Long and W. Copes *et al.*, 1996. Automated Coding of Injuries from Autopsy Reports; Quoted by Champion HR in Trauma, Appleton and Lange USA. 3rd Edn., pp: 66.