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USE OF THE ABBREVIATED INJURY SCALE IN A HOSPITAL EMERGENCY ROOM

Potential for Research in Accident Epidemiology

KNUD JØRGENSEN

Accident Analysis Group, Department of Orthopaedics,
Odense University Hospital, Odense, Denmark

Trauma, which accounts for a substantial part of the morbidity and mortality in industrial nations, is a natural area of interest for orthopaedic surgeons. Trauma, and trauma prevention, can be conveniently studied in emergency rooms and casualty units which are often run by hospital orthopaedic departments. In order to identify the most serious types of accidents and assign priorities as regards preventive measures it is necessary to be able to determine in an objective way the severity of different types of trauma. The Abbreviated Injury Scale is a system developed in the United States for ranking the severity of specific trauma lesions. This paper discusses general issues relating to injury scaling and accident epidemiology research.

Key words: accident prevention; accidents; emergency service hospital; epidemiologic methods; preventive medicine; traffic; wounds and injuries

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Hospital-based emergency medical care units have in recent years been increasingly exploited as valuable sources of information for accident epidemiology research. Important advances in preventive medicine can be made in emergency rooms, trauma units, casualty departments, etc., if systematic information can be collected routinely over a period of time. Several basic types of information are needed, including a description of the circumstances surrounding the accident, a summary of the lesions sustained, and an appraisal of the severity of the lesions. The last-mentioned type of information, severity of injury, is a necessary part of the data collection because it identifies the most dangerous types of accidents and allows the establishment of priorities as regards preventive measures. There are many factors to consider in developing a practical procedure for characterizing injury severity. In this paper some of the important elements of trauma analysis will be presented. The Abbreviated Injury Scale (AIS), a tool for ranking injury severity, will be discussed.

Before discussing the issue of injury severity scaling it is important to examine the concept of severity itself. The first question is *severity with respect to whom* – the individual patient, the medical care system, or society in general? Depending on the answer to this question, different definitions of severity are appropriate. To the individual patient perhaps the most important measure of injury severity is the threat to life. Other important measures include permanent impairment, disfigurement, and the amount of time required for recovery. Providers of medical care, on the other hand, may often prefer to measure injury severity on the basis of the amount and intensity of treatment required. For society in general the concept of trauma severity includes a concern for the number of people af-

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fected over a period of time. Clearly the purpose of each given investigation will determine the appropriate definition of injury severity, and the definition used will in turn point to specific trauma severity scaling methods.

Several simple and useful methods for indicating trauma severity commonly exist in hospital settings. Each patient can, for example, be categorized according to general level of care required (outpatient treatment plus referral for follow-up, inpatient admission, etc.). Patients can also be categorized according to the specific types of treatment received and/or the length of their hospital stay. Perhaps the most simple is the common system of classifying patients as either dead or alive at discharge. While these simple severity coding systems can be quite useful for certain types of investigations, none of them allows for in-depth analysis of trauma severity by type of lesion and region of the body affected. Furthermore, none of the commonly used indicators of severity consistently records the occurrence of potentially dangerous trauma which, due to good medical management or luck, did not result in serious consequences for the patient.

General requirements of a satisfactory scale for trauma severity

Ideally an injury scaling procedure should be as flexible as possible. Flexibility is necessary because severity scores can be used in a number of different types of investigations. In some cases, particular areas of the body are of concern (for example, in automobile safety belt research) while in other cases the patient's total injury severity is the focal point. A good injury scaling method should also be specific. Fine differences in pathology within a given region of the body, for example, should be distinguishable. As with all scales, one would hope to have a trauma severity scale which was both valid (i.e., a *real* measure of severity) and reliable (i.e., a *consistent* measure of severity – consistent for an individual user over a period of time and for several users scaling the same trauma patient). This of course requires that precise scaling criteria are available to users in written form. Finally, such a scale should be convenient to handle statistically.

Of primary importance for an injury scaling system is that the system should fit the setting in which it will be used. A crucial factor is the amount of time required to scale the average patient's lesions. In an emergency room environment, where service is geared to acute encounters, an easy scaling procedure is necessary. It is advantageous, for example, if several categories of personnel (physicians, nurses, medical secretaries, etc.) can scale trauma lesions.

Perhaps the most intuitive place to turn to for a good scale is the World Health Organization's International Classification of Diseases (ICD). The ICD system assigns a numerical identifier to various pathologic conditions, lesions, syndromes and symptoms. There are, however, considerable problems in directly utilizing the ICD codes to indicate trauma severity. First is the fact that there is no universally accepted ranking of ICD disease codes by severity, although an attempt has been made to develop a severity indicator for some lesion codes (Levy et al. 1978). Secondly, for a given trauma lesion code severity can vary considerably. A traumatic lesion to the heart, *laesio traumatica cordis* for example, is coded ICD 861.09 regardless of the severity.

THE ABBREVIATED INJURY SCALE

A detailed lesion-specific system for scaling injury severity has been developed. This system, the Abbreviated Injury Scale (AIS), was first devised in the late 1960's by the American Medical Association's Committee on Medical Aspects of Automotive Safety. Since then the system has undergone two significant revisions (American Association for Automotive Medicine 1980). The AIS is a detailed catalogue of specific lesions organized according to seven regions of the body. The scaling system utilizes six degrees of severity, numbered from one (for minor injuries) to six (for injuries which are untreatable and always fatal). Each given lesion is assigned a severity number on the basis of several criteria. There is some research evidence that the most important

of these criteria is the degree of threat to the victim's life (Huang & Marsh 1978).

AIS was developed primarily for use in traffic medicine. It focuses on injuries resulting from impacts with blunt or sharp objects, as well as burns. Injuries resulting from other causes (for example, poisoning, suffocation, over-exposure to the elements, gun shots, electric shock, extreme cold, irradiation and chemical corrosion) are not specifically included in the manual. For this reason trauma resulting from many home and occupational accidents cannot be scaled via AIS. Sports trauma can, however, often be scaled with the AIS system.

It is important to emphasize that in the AIS system the injury is coded but the *outcome* of injury (for example, temporary reduction of function, permanent disability, or death) is *not* coded. The distinction between trauma lesion and outcome of trauma lesion can be illustrated by comparing the severity score for an eye avulsion, 3, with that for a displaced fracture of the humerus, which is also scored 3. The score is equal despite the fact that the eye avulsion almost always results in blindness while the arm fracture rarely results in permanent disability. A further example of the AIS distinction between lesion severity and outcome is the case of a trauma victim who dies from a ruptured spleen. The victim's spleen lesion is scored four (not the maximum of six) in spite of the fatal outcome, because in the majority of such cases survival is probable (i.e., the threat to life is not as great as with some other lesions).

Options in using the Abbreviated Injury Scale

The AIS is a flexible tool for scaling injury severity. It can be used for a variety of purposes and types of investigations. It is detailed enough to be of use in studying trauma to specific body parts (for example, leg lesions). The AIS is likewise broad enough to be of use in characterizing the entire pattern of injury resulting from given accident situations (for example bicycle-versus-automobile accidents). Because it is so flexible a tool a number of practical decisions have to be made before putting the AIS to systematic use. Unfortunately the AIS manual itself does not present or explain the full range of options that are available.

The first decision which must be made in using the AIS to scale trauma severity is *whose* lesions to scale. The possible choices range from scaling the injury of all victims (for general surveillance projects) to scaling lesions of a select group of victims who meet a specified set of criteria (for example, age, sex, type of accident, type of lesion, etc.). The specific motivation for trauma severity scaling will in most instances define the type of patients to be included. It is important to bear in mind when selecting the patient population to be studied that, as mentioned above, the AIS system does not work equally well for all types of trauma.

A second major issue to resolve in using AIS concerns the questions as to what type of personnel on the hospital staff should be responsible for severity scaling, and at what point in the patient's diagnosis and treatment the scaling should be done. There are many possible choices here. The scaling can be accomplished by physicians, nurses, medical secretaries or other categories of trained personnel. It can be done on the basis of the initial diagnostic examination at the time when the patient presents for treatment, or at a later stage on the basis of more definitive medical documentation. Some research has been done to compare the reliability of various types of medical records. As expected, the more thorough the diagnosis, the better the quality of severity coding (Mackenzie et al. 1978).

An intelligent choice as to a practical lesion scaling procedure is only possible after a careful review of the emergency room treatment routine, the flow of paper, the work load of the personnel and the potential for cooperation between various hospital departments and related institutions. Whatever the procedure chosen it must be applied consistently in a standard manner to all victims who meet the criteria for inclusion. To score some patients via one procedure and other patients via another procedure risks introducing a bias which may make it impossible to interpret the compiled severity data.

Coding trauma information for convenient handling

In planning for routine handling of injury severity data a decision must be made as to how to code lesion information. A good coding system will provide a simplified abstraction of the potentially complex pattern of injury, while at the same time maintaining an adequate degree of specificity. The pattern of injury can be coded along several dimensions including 1) the parts or regions of the body affected, 2) the types of tissue involved (vessels, nerves, muscles, organs and bone, etc.) 3) the nature of the lesion (abrasion, laceration, rupture, avulsion, etc.), and, of course, 4) the severity. A decision has to be made as to the degree of precision desired along each dimension.

When first considering the issue of precision it is natural to conclude that the most desirable solution is to have as much precision as possible along all dimensions. This implies that the *exact* anatomical site of the trauma be coded, and likewise that the *exact* nature of the lesion and tissue type involved be coded. However, too high a degree of precision can be as big a problem as too low a degree. The more precise the coding system, for example, the more time is required to code an individual patient and the more dependent the coder is on precise medical documentation. Obviously some practical compromise must be reached in order that each individual lesion (which is, after all, unique at a cellular level) can be meaningfully grouped with other similar lesions. In general, the purpose of the investigation, the expected number of victims during the study period, and the analytic requirements should determine the degree of precision which is appropriate. In some investigations it may not be necessary to code all lesions.

Body regions. The AIS manual itself is divided into seven anatomical categories: head, neck, thorax, abdomen and pelvic contents, spine, extremities and bony pelvis, and a final category called "external" which includes skin and muscles throughout the body. It is important to realize that the organization of lesions into these seven anatomical categories is simply a device to assist the user in locating the individual lesion scale values in the manual.The anatomical categories do not themselves dictate how the pattern of trauma should be coded in any given study. For example, a study of lesions sustained in automobile-versus-pedestrian impacts might well require that arm lesions be coded separately from leg lesions. In fact leg lesions might well be divided into foot, ankle, shin, knee, thigh and hip for coding purpose. No matter what the final decision regarding the body regions to be coded it is necessary to define the regions carefully, specifying both skin boundaries and internal contents.

Tissue and lesion type. In general the AIS coding manual does not lend itself easily to precise coding by tissue and lesion type. An alternative coding system which has been developed for this purpose is The Occupant Injury Classification (OIC) which serves as a good example of an integrated coding approach involving several dimensions (Marsh 1972). No matter how tissue and lesion type are coded, if at all, a decision must be made concerning two common and difficult situations. Firstly, it is necessary to establish a code for accident victims who in fact have not sustained physical injury and do not present with complaints. Such persons involved in an accident are often brought to hospital because they are upset or simply because a witness was impressed by the drama of the situation. Secondly, a rule must be established for victims who come to the emergency room complaining of pain without showing real signs of injury. According to official AIS doctrine, pain is an outcome of injury and should therefore not be given a severity code. It is conceivable, however, that in certain investigations AIS-1 could be used for such victims.

Statistical analysis and other issues

After trauma information has been coded, a decision must be reached as to how to present the information statistically. Unfortunately the AIS manual does not give the user a great deal of advice on this issue. A most important point to consider in planning an analytical approach is that the AIS system constitutes an *ordinal* scale. In such a scale one may assume that a scale value

of three is less than a scale value of four, four is less than five, etc. In other words the scale is set up to rank injury severity. One cannot be certain however of the actual increment in injury severity which is represented by an increase of one in scale value. Furthermore, one is not certain whether an increase from three to four represents the same change in severity as an increase from four to five. Certain statistical techniques are appropriate for ordinal scales and others are not. Before undertaking sophisticated analysis one would be well advised to consult with a statistician.

As for an appropriate overall measure of trauma severity among patients with multiple injuries, the AIS manual reviews several alternative procedures.

The field of accident epidemiology in general, and within it the issue of injury severity scaling, is in a rapid state of development. Many attempts are currently being made to develop ways of identifying dangerous consumer products, activities and accident situations (see for example Organization for Economic Co-operation and Development 1979). Providers of emergency medical care can contribute greatly to the refinement of techniques for 1) signalling dangers to the public health, and 2) evaluating the effectiveness of various prophylactic programs. In order to do this medical information from the hospital must be combined with basic information on the mechanism of the injury and the circumstances of the accident.

REFERENCES

American Association for Automotive Medicine (1980) *The abbreviated injury scale, 1980 revision.* American Association for Automotive Medicine, Morton Grove, Illinois, USA.*

Huang, L. C. & Marsh, J. C. (1978) AIS and threat to life. *Proceedings of the 22nd Conference of the American Association for Automotive Medicine,* pp. 242–254. American Association for Automotive Medicine, Morton Grove, Illinois, USA.

Levy, P. S., Mullner, R., Goldberg, J. & Gelfand, H. (1978) The estimated probability index of trauma severity. *Health Services Research* 13–1, pp. 28–35.

MacKenzie, E. J., Garthe, E. A. & Gibson, G. (1978) Evaluating the abbreviated injury scale. *Proceedings of the 22nd Conference of the American Association for Automotive Medicine.* Vol. 1, pp. 55–66. American Association for Automotive Medicine, Morton Grove, Illinois, USA.

Marsh, J. C. (1972) Existing traffic accident injury causation data recording methods and the proposal of an occupant injury classification scheme. *Proceedings of the 16th Conference of the American Association for Automotive Medicine,* pp. 44–61. American Association for Automotive Medicine, Morton Grove, Illinois, USA.

Organisation for Economic Co-operation and Development (1979) *Severity weighting of data on accidents involving consumer products.* Organisation for Economic Co-operation and Development, Paris.

Correspondence to: Knud Jørgensen, M.D., Accident Analysis Group, Odense University Hospital, DK-5000 Odense C, Denmark.

* The 1980 AIS manual (in English) can be ordered from AIS REGISTRY, P.O. Box 222, Morton Grove, Illinois 60053, USA. The price is US $ 7.00 plus US $ 3.00 for overseas postage.