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Defining major trauma using the 2008 Abbreviated Injury Scale

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ABSTRACT

Background: The Injury Severity Score (ISS) is the most ubiquitous summary score derived from Abbreviated Injury Scale (AIS) data. It is frequently used to classify patients as 'major trauma' using a threshold of ISS >15. However, it is not known whether this is still appropriate, given the changes which have been made to the AIS codeset since this threshold was first used. This study aimed to identify appropriate ISS and New Injury Severity Score (NISS) thresholds for use with the 2008 AIS (AIS08) which predict mortality and in-hospital resource use comparably to ISS >15 using AIS98.
Methods: Data from 37,760 patients in a state trauma registry were retrieved and reviewed. AIS data coded using the 1998 AIS (AIS98) were mapped to AIS08. ISS and NISS were calculated, and their effects on patient classification compared. The ability of selected ISS and NISS thresholds to predict mortality or high-level in-hospital resource use (the need for ICU or urgent surgery) was assessed.
Results: An ISS >12 using AIS08 was similar to an ISS >15 using AIS98 in terms of both the number of patients classified major trauma, and overall major trauma mortality. A 10% mortality level was only seen for ISS 25 or greater. A NISS >15 performed similarly to both of these ISS thresholds. However, the AIS08-based ISS >12 threshold correctly classified significantly more patients than a NISS >15 threshold for all three severity measures assessed.
Conclusions: When coding injuries using AIS08, an ISS >12 appears to function similarly to an ISS >15 in AIS98 for the purposes of identifying a population with an elevated risk of death after injury. Where mortality is a primary outcome of trauma monitoring, an ISS >12 threshold could be adopted to identify major trauma patients.
Level of evidence: Level II evidence—diagnostic tests and criteria.

Background

The Injury Severity Score (ISS) [1] is the oldest and best-known summary score derived from Abbreviated Injury Scale (AIS) [2] data. In the four decades since its initial development, other AIS-based summary scores have been developed [3–7], which are capable of outperforming ISS in predicting mortality following severe injury [5–8]. In spite of this, the simplicity and ubiquity of the ISS have resulted in its continued use (and recommendation) [9] in grouping or discriminating between trauma patients, and severity adjustment in comparisons of trauma populations. Importantly, the ISS has often been used to define a threshold (or cut-off value) for the classification of 'major trauma'—an otherwise arbitrary description of severely injured patients within a larger trauma patient population. This may be used as an inclusion criterion for a registry or research study population, or identifying a severely injured cohort within a more inclusive registry.

Since the 1980s, an ISS of greater than 15 has been the most commonly used threshold for defining major trauma [9,10]. Boyd et al. first described and adopted this threshold as predictive of 10% mortality [11]. However, although data from this study indicated that younger patients with ISS between 16 and 24 had a mortality of around 10%, overall mortality for patients with ISS >15 was more than 20% [12]. Also, mortality rates varied substantially depending on the body regions injured, the mechanism of injury and the specific ISS value evaluated [11]. Finally, it is not known

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why a 10% mortality risk in particular was selected in establishing an ISS threshold.

The study data used by Boyd et al. [11] calculated ISS values from AIS codes using the 1985 version of the AIS. The magnitude and breadth of codeset changes introduced between the 1985 and 1998 releases (AIS98) were overall sufficiently small that the continued use of ISS >15 with AIS98-coded data remained reasonable. However, between AIS98 and the current AIS revision (AIS08, updated in 2008) [2] the AIS codeset was extensively modified and expanded, in part to reflect improvements in the diagnosis, management, classification and expected outcomes of injury. The resultant effects on patient classification in trauma registries are substantial and significant, and have been well-described [13–15]. As a result, even if an ISS >15 threshold corresponded to 10% mortality using older AIS versions, it may not satisfactorily differentiate between patients with lower and higher mortality rates when AIS08 is used to classify injuries [10,13].

Alternative thresholds based on NISS have also been proposed. The Utstein template [16], developed to standardise trauma monitoring across Europe, recommends the use of NISS >15 for registry inclusion. It has been suggested that this improves the sensitivity of patient capture without compromising specificity [16], although no studies have assessed this using AIS08. However, the NISS is equally susceptible to the classification differences between AIS versions which have affected the ISS [17]. Also, in spite of its limitations the ISS (and in particular the ISS >15 threshold) is still the most widely used trauma score [3], even within European registries [18].

Finally, although the AIS is associated with a range of trauma outcomes including mortality, in-hospital resource requirements and the extent of temporary or permanent disability and impairment [2], scores derived from AIS codes all used mortality as the sole or predominant outcome in their development [4–7]. As mortality rates from trauma have decreased with the introduction of trauma systems in developed countries, measurements of morbidity and the quality of survival (such as longer-term outcomes) have become more important [19,20]. As a result, although it is important to be able to link the use of existing scores such as the ISS across different AIS versions, such measures should not replace the development or evaluation of more contemporary, morbidity-based measures.

Objectives

The primary aim of this study was to identify ISS and NISS thresholds, based on AIS08-coding, which perform similarly to the earlier ISS > 15 threshold for AIS98-coded data in predicting mortality following trauma. This provided for two considerations—firstly, the need for more contemporary major trauma definitions (i.e., using the most current AIS version); secondly, the desire to maintain comparable numbers of patients classified as major trauma using both old and new thresholds. Secondary aims of interest were to evaluate the variability in mortality across a range of possible ISS and NISS values, and to assess ISS and NISS thresholds in measuring in-hospital service requirements.

Methods

The Victorian State Trauma Registry (VSTR) is a well-established registry collecting data on hospitalised major trauma, and many other severely injured patients managed in the Australian state of Victoria. Data are collected from all hospitals in the state which receive trauma patients. The VSTR was established in July 2001, with AIS98 used to code anatomical injuries sustained by patients until June 2010. AIS codes were assigned by trained coders, working both in Victorian hospitals and for the VSTR.

While AIS98 was being used by the VSTR, major trauma was defined within Victoria as not only patients who sustained injuries with an ISS >15, but also those who died, required more than 24 h in an ICU (with mechanical ventilation) or needed urgent surgical management. The registry also includes patients with a total hospital length of stay greater than 72 h, while excluding some isolated facial, limb or superficial injuries and isolated femoral neck fractures. Complete inclusion and exclusion criteria for the VSTR are published elsewhere [21].

Data for all patients meeting VSTR inclusion criteria over the 9 year period from July 2001 to June 2010 were used in this analysis. Using a validated mapping tool [22,23], equivalent AIS08 codes were derived from the existing AIS98 codes, together with free text injury descriptions where appropriate. Two ISS values were calculated for each patient using AIS98 and AIS08 codes (termed ISS98 and ISS08); NISS scores were also calculated using AIS08 data (termed NISS08). These were combined with in-hospital mortality data to derive cumulative mortality rates at or above each possible ISS and NISS value. For both ISS08 and NISS08 data, thresholds were selected which returned a similar mortality rate to the ISS > 15 threshold as used with AIS98 data.

The need for ICU admission (with or without mechanical ventilation) or urgent surgery (using VSTR criteria) [21] were also obtained for secondary comparisons as proxy measures of in-hospital resource use. Contingency tables were generated, and McNemar's chi-square test used to compare the AIS08-based thresholds in terms of their ability to correctly classify patients who died or needed ICU or urgent surgery. For each outcome measure, the proportions of patients who were correctly classified (i.e., either a 'true positive' or a 'true negative' within each contingency table) were also calculated, and differences in these between the AIS08-based thresholds were evaluated. Confidence intervals were calculated at the 95% level.

Results

Data for 38,535 severely injured patients were extracted from the VSTR. Coded using AIS98, these patients sustained a total of 153,449 injuries; following mapping, 158,284 AIS08 codes were derived due to injury classification differences (particularly relating to chest and pelvic injuries) between AIS98 and AIS08 [22]. ISS98, ISS08 and NISS08 scores were calculated for 37,760 patients. The remaining patients either sustained injury types which were not codeable in both AIS98 and AIS08 (such as drowning) or sustained isolated non-specific (AIS level '9') injuries for which summary scores could not be calculated.

The age and gender profile of VSTR patients is shown in Fig. 1. Below the age of 80 years, more males than females were injured in every age group. The incidence of trauma amongst males peaked in the 20–24 years age group, while for females the peak incidence was seen in patients aged 80–84 years.

Overall population descriptions using ISS and NISS

Of patients with available summary scores, 2340 patients died. This gave a crude mortality rate for the VSTR population of 6.2% (95% CI 6.0, 6.4%). There were 15,757 patients with ISS98 >15 (41.7% of the dataset; 95% CI 41.2, 42.2%); of these, 1799 patients (11.4%; 95% CI 10.9, 11.9%) died.

Fig. 2 shows mortality rates for a range of moderate to severe individual ISS and NISS values calculated from VSTR data. Below scores of 25, the mortality risk associated with specific ISS08 and NISS08 values remained low—as low as 3.1% for an ISS08 of 19, and 1.9% for a NISS08 of 17. A 10% mortality level was not seen for any of the AIS-derived scores until values of 25 or higher.