The quest for a universal definition of polytrauma: A trauma registry-based validation study

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BACKGROUND: A pilot validation recommended defining polytrauma as patients with an Abbreviated Injury Scale (AIS) score greater than 2 in at least two Injury Severity Score (ISS) body regions (2 × AIS score > 2). This study aimed to validate this definition on larger data set. We hypothesized that patients defined by the 2 × AIS score > 2 cutoff have worse outcomes and use more resources than those without 2 × AIS score > 2 and that this would therefore be a better definition of polytrauma.

METHODS: Patients injured between 2009 and 2011, with complete documentation of AIS by New South Wales Trauma Registry and 16 years and older were selected. Age and sex were obtained in addition to outcomes of ISS, hospital length of stay (LOS), intensive care unit (ICU) admission, ICU LOS, and mortality. We compared demographic characteristics and outcomes between patients with ISS greater than 15 who did and did not meet the 2 × AIS score > 2 definition. We then undertook regression analyses (logistic regression for binary outcomes [ICU admission and death] and linear regression for hospital and ICU LOS) to compare outcomes for patients with and without 2 × AIS score > 2, adjusting for sex and age categories.

RESULTS: In the adjusted analyses, patients with 2 × AIS score > 2 had twice the odds of being admitted to the ICU compared with those without 2 × AIS score > 2 (odds ratio, 2.5; 95% confidence interval [CI], 2.2–2.8) and 1.7 times the odds of dying (95% CI, 1.4–2.0; p < 0.001 for both models). Patients with 2 × AIS score > 2 also had a mean difference of 1.5 days longer stay in the hospital compared with those without 2 × AIS score > 2 (95% CI, 1.4–1.7) and 1.6 days longer ICU stay (95% CI, 1.4–1.8; p < 0.001 for all models).

CONCLUSION: Patients with 2 × AIS score > 2 had higher mortality, more frequent ICU admissions, and longer hospital and ICU stay than those without 2 × AIS score > 2 and represents a superior definition to the definitions for polytrauma currently in use. (J Trauma Acute Care Surg. 2014;77: 620–623. Copyright © 2014 by Lippincott Williams & Wilkins)

LEVEL OF EVIDENCE: Diagnostic test/ criteria, level III.

KEY WORDS: Polytrauma; consensus definition; trauma; Injury Severity Score.

The current terminology surrounding the severely injured lacks both clarity and consensus, particularly in relation to the term polytrauma.1–4 While polytrauma patients are generally regarded to be the most severely injured patients with two or more significant injuries, the use of the term both clinically and in the literature is inconsistent.5–14 Illustrating this fact, we conducted a recent study based on subjective assessments and found that trauma surgeons do not agree on the definition of polytrauma, with subjective definitions differing both within and across institutions.15

An Injury Severity Score (ISS) greater than 15 is a frequently used definition for both polytrauma and the interchangeably used terms of severely injured and major trauma. Its use as a formal definition however has not been established according to the traditional rules of evidence.16–21 Moreover, this anatomic cutoff makes no distinction between single-system severe injury (e.g., an Abbreviated Injury Scale [AIS] score of 4 or 5 in one region) and what is generally regarded as true polytrauma, with the most concerning aspect being the potential overrepresentation of isolated head injuries.

In a prospective pilot validation study undertaken on 336 patients, we previously suggested the division into AIS body regions as a way around some of the inherent limitations of the ISS when used to define polytrauma.22 We recommended defining polytrauma as those patients with AIS score of greater than 2 in at least two ISS body regions (2 × AIS score > 2). This definition was shown to be a better predictor of morbidity and mortality than the most commonly used ISS > 15 definition and excluded those patients with severe single-system injuries (monotrauma), the most important implication being the exclusion of patients with isolated head injuries who have an inherently higher morbidity and mortality rate but do not represent true polytrauma.23–25 The need to further evaluate the results of this pilot study was highlighted at the time of publication. As such, the aim of the current study was to validate these preliminary results on a larger data set, specifically the New South Wales (NSW) (Australia) Trauma Registry. We hypothesized that, in patients with ISS greater than 15, the subgroup of polytrauma patients defined by the 2 × AIS score...
> 2 cutoff have worse outcomes and use more resources than those without 2 × AIS score > 2 and that this would therefore be a better definition of polytrauma.

**PATIENTS AND METHODS**

**The NSW Trauma Registry**

The NSW Trauma Registry is a statewide registry established by the NSW Institute of Trauma and Injury Management (NSW ITIM) in 2002. The data set held by the registry is known as the NSW Trauma Minimum Data Set, an online mandatory requirement of all NSW-designated trauma services. Data are submitted to a central password-protected database server, hosted securely within NSW Health. Criteria for patient inclusion into the NSW Trauma Registry as determined by the NSW ITIM are as follows: admission to a trauma service in NSW within 14 days of injury; any patient with ISS > 12; and death in the hospital (irrespective of ISS). Exclusion criteria, as determined by the NSW ITIM, include having isolated fractured neck of femur injuries sustained after a mechanical fall.

The NSW trauma minimum data set consists of 20 mandatory data elements composing of demographic characteristics, transfer and admission data, mechanism of injury, intensive care admission details and LOS, surgical intervention, and ultimate outcome (survival/death). Before 2009, only the ISS was collected. In 2009, AIS codes for each component injury became mandatory. Physiologic and laboratory data do not form part of the NSW trauma minimum data set.

**Study Population**

Our study population was drawn from the NSW trauma registry and included all patients with ISS > 15 occurring between 2009 and 2011. The study period was chosen because AIS codes were not mandatory before 2009; thus, from 2009, there was complete documentation in the registry for ISS plus component AIS codes for each body region. We excluded patients younger than 16 years. Demographic characteristics including age and sex were recorded. Hospital LOS, ICU admission, ICU LOS, and mortality constituted the key outcomes for investigation.

**Statistical Analysis**

Analyses were undertaken using the Stata statistical software (Stata Statistical Software, Release 12, StataCorp LP, College Station, TX). Descriptive statistics are presented as mean (SD) for normally distributed continuous variables (age), median (first and third quartile) for nonnormally distributed continuous variables (ISS, hospital LOS, and ICU LOS) and frequency distributions (n [%]) for binary variables.

We compared demographic characteristics and outcomes between patients with ISS > 15 who did and did not meet the 2 × AIS score > 2 definition using the χ² test for categorical variables and the Mann-Whitney rank-sum test for continuous variables. We then undertook regression analyses (logistic regression for binary outcomes [ICU admission and death] and linear regression for hospital and ICU LOS) to compare outcomes for patients with and without 2 × AIS score > 2, adjusting for sex and age category (16–45, 46–70, 71+). Because LOS was highly skewed, we used a log transformation of this variable. Models also adjusted for trauma facility, and robust variance estimates were obtained. Results from the regression models are reported as adjusted odds ratios (ORs) (for ICU admission and death) and geometric means (for LOS) with 95% confidence intervals (CIs), and the Wald test was used to assess statistical significance of associations.

Post hoc power calculations estimated that this study had 80% power, using a 5% significance level, to detect differences of 3% in mortality, 2.5% in ICU admission rate, 3.5 days in hospital LOS, and 1.5 days in ICU LOS between those with and without 2 × AIS score > 2.26 These were considered to be clinically relevant differences taking into account the costs of hospital and ICU LOS, the increased health risk of prolonged hospital admissions such as hospital-acquired pneumonia, and the psychosocial impact of trauma such as quality of life and loss of productivity.27,28

**RESULTS**

After applying the inclusion and exclusion criteria of our study to the NSW trauma registry database, there were a total of 4,935 patients in our study, of whom 1,454 (29%) had an AIS score > 2 in at least two of the six ISS body regions (2 × AIS score > 2). Characteristics for the total group were as follows: mean (SD) age, 52.4 (23.3) years, 3,547 males (72%), ISS of 22 (Q1-Q3, 17–26), hospital LOS of 10 days (Q1–Q3, 5–22 days), 2,204 admitted to ICU (45%), ICU LOS of 0 day (Q1–Q3, 0–3 days), and mortality of 721 (15%) (Table 1).

Patients with 2 × AIS score > 2 were younger than those without 2 × AIS score > 2 (mean age, 46.5 and 54.9 for those with and without 2 × AIS score > 2, respectively; p < 0.001). There was a marginally nonsignificantly higher proportion of males among those with 2 × AIS score > 2 relative to those without 2 × AIS score > 2; however, this difference was not clinically meaningful (74% males in the 2 × AIS score > 2 group vs. 71% males in those without 2 × AIS score > 2, p = 0.061). ISS was statistically significantly higher for patients with 2 × AIS score > 2 (median, 29) versus those without 2 × AIS score > 2 (median, 20; z = -3.597; p < 0.001).

Hospital LOS and ICU LOS were both statistically significantly longer for the 2 × AIS score > 2 group compared with those without 2 × AIS score > 2 (median hospital LOS of 16 days for those with 2 × AIS score > 2 vs. 9 days for those without 2 × AIS score > 2 [z = -13.25, p < 0.001] and median ICU LOS of 1 day and 0 day for those with and without 2 × AIS score > 2, respectively [z = -15.92, p < 0.001]). Patients with 2 × AIS score > 2 were statistically significantly more likely to be admitted to the ICU (59%) relative to those without 2 × AIS score > 2 (39%; χ² = 176.70, df = 1, p < 0.001) and had higher mortality (18% for 2 × AIS score > 2 vs. 14% for those without 2 × AIS score > 2; χ² = 12.20, df = 1, p < 0.001).

In adjusted analyses, patients with 2 × AIS score > 2 had twice the odds of being admitted to the ICU compared with those without 2 × AIS score > 2 (OR, 2.5; 95% CI, 2.2–2.8) and 1.7 times the odds of dying (95% CI, 1.4–2.0; p < 0.001 for both models) (Table 2). Patients with 2 × AIS score > 2 also had a mean difference of 1.5 days longer stay in the hospital compared with those without 2 × AIS score > 2 (95% CI,
Y 1.7) and 1.6 days longer ICU LOS (95% CI, 1.4–1.8; \( p < 0.001 \) for both models).

**DISCUSSION**

This study has aimed to refine the way that polytrauma patients are defined distinct from those with multiple but non-serious injuries and also from those with single-system severe trauma. Comparing patients with and without 2 × AIS score > 2, the study found that patients with 2 × AIS score > 2 had a higher overall ISS compared with those without 2 × AIS score > 2 (29 [22–38] vs. 20 [17–25]), longer hospital stay (16 [7–33] days vs. 9 [4–18] days), higher ICU admission rates (59% vs. 39%), longer ICU stay (1 [0–7] days vs. 0 [0–2] days), and a higher mortality rate (18% vs. 14%). After adjustment for age and sex, this study found that patients with 2 × AIS score > 2 had 1.7 times the odds of dying and 2.5 times the odds of being admitted to the ICU than those without 2 × AIS score > 2, with a mean of 1.5 days longer hospital stay and a mean of 1.6 days longer ICU stay.

The NSW Trauma Registry is not designed to assess the role that physiologic parameters could play in a definition of polytrauma, as it does not mandate the collection of physiologic data. As a result, this study has focussed purely on anatomic scores. The specific aim of this study was to look at simple AIS-based anatomic scoring to potentially improve the definition of polytrauma. Our results showed that a simple change in the definition (from ISS > 15 to AIS score > 2 in two or more regions) improves the use of the AIS-based scoring. This can be applicable even retrospectively to any registry. However, since parameters such as blood pressure, degree of acidosis, and level of consciousness characterize the host response

### TABLE 2. Regression Analyses of Outcomes for Patients With 2 × AIS Score > 2 Versus Those Without 2 × AIS Score > 2*

<table>
<thead>
<tr>
<th>Binary Outcomes</th>
<th>OR**</th>
<th>95% CI</th>
<th>( \chi^2 )</th>
<th>df</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU admission</td>
<td>2.5</td>
<td>2.2–2.8</td>
<td>176.34</td>
<td>1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mortality</td>
<td>1.7</td>
<td>1.4–2.0</td>
<td>35.17</td>
<td>1</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

**Models adjusted for sex, age group, and trauma center; robust variance used.

**OR for outcome in those with 2 × AIS score > 2 relative to those without 2 × AIS score > 2.

†Coefficient estimates and 95% CIs are obtained from the regression of the ln of length of stay, and then exponentiated to provide estimate on the original scale.

‡Geometric difference in mean LOS between those with 2 × AIS score > 2 relative to those without 2 × AIS score > 2.
to injury and indeed some have been shown to predict outcome in trauma, combining physiologic parameters with an anatomic score could improve the sensitivity and specificity of any future definition of polytrauma and is recommended. The inclusion of the right physiologic parameters (based on international consensus) in addition to $2 \times$ AIS score $>2$ anatomic criteria should lead to a superior definition, which may affect the variables recommended to be collect by trauma registries.

CONCLUSION

The trauma community has reached a critical point in governing the use of one of its most commonly used terms, polytrauma. Clear boundaries are needed to guide when and to whom this definition should be applied. This study has confirmed on a large data set the superiority of using the $2 \times$ AIS score $>2$ definition to define polytrauma. It captures a more severely injured, more resource-intensive patient population with a higher mortality rate, even without the inclusion of physiologic parameters, while excluding severe single-system injuries (monotrauma) that are not clinically considered polytrauma.

AUTHORSHIP

N.E.B and Z.J.B designed the study. N.E.B and C.D conducted the statistical analysis and drafted the manuscript. C.D and Z.J.B provided critical revision.

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DISCLOSURE

The authors declare no conflicts of interest.

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