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The New Injury Severity Score: Better Prediction of Functional Recovery after Musculoskeletal Injury

Alasdair G. Sutherland, MD (Hons), FRCSEd (Tr&Orth), Andrew T. Johnston, MRCSEd, James D. Hutchison, PhD

Department of Orthopaedics, University of Aberdeen, Aberdeen, UK

ABSTRACT

Objectives: Injury Severity Score (ISS) is the most widely used method of assessing severity of injury in blunt trauma. It has been recognized that, by only allowing the score to consider the worst injury for each body system, ISS underestimates the problems of multiple musculoskeletal injuries. The New ISS (NISS) allows the three most severe injuries to be scored, irrespective of region affected, and may give better prediction of functional recovery in these patients.
Methods: A prospective cohort study of 200 patients with musculoskeletal injuries, examining the predictive value of ISS and NISS on functional recovery as measured by patient-derived outcome measures (Short Form-36, Sickness Impact Profile, and Musculoskeletal Function Assessment).
Results: NISS was greater than ISS in 34 patients (17%). NISS showed closer correlation with total scores and subscores of the outcomes measures than did ISS (Spearman's rho ranked test, $P < 0.05$).
Conclusions: NISS, a simple modification from ISS, better predicts functional outcomes in survivors of musculoskeletal trauma, and offers an improvement in the assessment of effectiveness of trauma care delivery.
Keywords: injury, musculoskeletal, recovery, severity score.

Introduction

The challenge in assessing the effectiveness of delivery of health care in musculoskeletal trauma is that of assessing the recovery of an extremely heterogeneous patient group. No two injuries are exactly alike, and when patients have multiple injuries the difficulties of comparing patients are magnified. Studies that focus on single injury types are difficult enough, because of the differences present even in relatively limited patient populations; assessing the effectiveness of overall trauma care as a system in terms of functional recovery for all comers by looking at individual injury types becomes effectively impossible. We need a way to compare the overall severity of a patient's injuries, so that comparison of the initial injury with functional recovery can provide a basis for assessing the overall effectiveness of a trauma system. The development of the Abbreviated Injury Score (AIS) [1] and the subsequent Injury Severity Score (ISS) [2] were significant steps toward the goal of estimating the probability of an individual surviving an injury or combination of injuries. They have further been used to compare treatment methods, delivery of treatment and the performance of treating doctors in trauma care [3], but not without difficulties.

Address correspondence to: Alasdair G. Sutherland, Department of Orthopaedics, Polwarth Building, Foresterhill, Aberdeen, AB25 2ZD, UK. E-mail: ort025@abdn.ac.uk
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In the assessment of the patient with multiple injuries, the AIS allows each injured region (external, head and face, neck, thorax, abdomen/pelvic contents, spine, extremities/bony pelvis) to be given a single score from 1 (minor) to 6 (regarded as unsurvivable), but does not allow any combination of these scores. The ISS is a refinement of the AIS, taking the squares of the highest three AIS region scores together to give a single, nonlinear score. The ISS has become the most widely used score for evaluating patients with multiple injuries from blunt trauma [4].

Although these scores were developed with a view to predicting survival after multiple injuries, they are used, formally and informally, in the prediction of outcomes other than death, such as functional impairment [3,5]. The ISS has significant shortcomings in the assessment of multiple musculoskeletal injuries. In a patient with multiple fractures, the ISS will only factor in the most severe axial skeleton injury, and may underestimate the overall severity by ignoring other significant skeletal injuries [3,6]. The result of this is that a patient with a single long bone fracture will have a similar ISS score to a patient with multiple fractures, controlling for other associated injuries. To overcome this shortcoming, a new version of the ISS, the New ISS (or NISS), has been developed [7]. The NISS takes the three most severe AIS values, irrespective of body region, with the aim of taking full account of multiple injuries in the same body region, particularly musculoskeletal injuries.

The NISS has been shown to increase the apparent injury severity in multiple trauma, and to predict more accurately short-term mortality [4,7–9] and extended hospital and intensive care unit stay [10,11]. We wished to evaluate whether it would also better predict functional outcome 6 months after musculoskeletal trauma.

Materials and Methods

As part of a wider study of trauma outcomes, a cohort of patients treated in the Orthopaedic Trauma Unit of Aberdeen Royal Infirmary was recruited between April 1, 1999 and February 23, 2000. Patients eligible for entry were aged 17 to 70 years old, with at lease one musculoskeletal injury. As we wished to focus on the recovery of musculoskeletal injuries, those with significant head injuries (unconscious more than 15 min, Glasgow Coma Scale less than 13) were excluded. Patients with low energy, osteoporotic, fractures were also excluded. Two hundred patients were successfully entered into the study, and completed initial documentation. All were invited to complete the Short Form-36 (SF-36), Sickness Impact Profile (SIP), and Musculoskeletal Function Assessment (MFA) patient-derived outcome measure at 6 months after their injury.

For complete accuracy of scoring ISS, retrospective scoring is often necessary, even to the extent of using autopsy information [12], as complete information on the extent of the injuries may take time to become clear. We scored ISS and NISS based on completed information in medical charts at the time of discharge.

The SF-36 is a valid, sensitive, and reliable measure of change in health status, and was first introduced in 1992 [13,14]. It has been validated for use in the northeast of Scotland [15], and the latest version (SF-36 II) has been further validated in a general UK population [16]. This version was used in the present study, and will be referred to generically as SF-36. The MFA was developed with the aim of combining the benefits of disease-specific outcomes measures in musculoskeletal conditions with the robustness of more general patient-derived outcomes measures such as SF-36 [17,18]. The SIP is a behavior-based health status questionnaire, developed in the 1970s and widely used since [19,20]. All three instruments produce a series of subscales and the MFA and SIP produce an overall total score.

Analysis of the relationship between trauma scores (ISS and NISS) and outcomes scores was by the Spearman's rho ranked test using the Statistical Package for Social Sciences (SPSS v9.1, SPSS Inc., Chicago, IL, USA) on a personal computer. ISS and NISS are not continuous variables, produced as they are by summing the squares of up to three AIS score (each ranging from zero to six). All scores produced are whole numbers and, for example, a score of seven on ISS or NISS is not possible for simple arithmetic reasons. Therefore, ISS and NISS cannot be evaluated as continuous variables, particularly in comparison with continuous variables such as SF-36, SIP or MFA scores, where a simple correlation analysis would be invalid [21]. For this reason, analysis was by Spearman's rho ranked test; to ensure assessment of scores by ordered but noncontinuous ISS and NISS values. No adjustments were made for multiple statistical testing.

Results

Two hundred patients were recruited to a wider study of trauma outcomes, and were taken from admissions to the Orthopaedic Trauma Unit of Aberdeen Royal Infirmary between April 12, 1999 and February 12, 2000. The mean age of the patients was 37 years (range 16–68 years), and 136 (68%) were male. Mechanism of injury was road traffic accident in 33%, falls in 39%, sports in 13%, and work in 11%. Patients had sustained a variety of musculoskeletal injuries, predominantly fractures, with 46 (23%) having multiple injuries. The mean ISS was 8.21 (median 9.00, range 4–32) and the mean NISS 9.25 (median 9.00, range 4–41). NISS was higher than ISS in 34 cases (17%).

At 6 months, 150 patients (75%) completed follow-up. The patients that did not complete follow-up were not statistically different from those that did so, in terms of ISS, NISS, or demographics, and they simply failed to return completed forms, in spite of repeated reminders. There were no deaths during the study period. The correlation between the continuous outcomes scores generated by each of the three measures, and the ISS and NISS scores are shown in Tables 1–3. In each table, where the NISS gives stronger correla-

Table 1 Comparison of SF-36 scale score correlation with ISS and NISS (Spearman's rho ranked correlation)

	ISS	NISS
Physical Function	−0.339 $P < 0.001$	−0.362 **$P < 0.001$**
Social Function	−0.345 $P < 0.001$	−0.353 **$P < 0.001$**
Physical Role Limitation	−0.371 $P < 0.001$	−0.382 **$P < 0.001$**
Emotional Role Limitation	−0.284 $P = 0.001$	−0.288 **$P < 0.001$**
Mental Health	−0.155 $P = 0.061$	−0.171 **$P = 0.039$**
Energy	−0.116 $P = 0.161$	−0.137 **$P = 0.099$**
Pain	−0.201 $P = 0.015$	−0.224 **$P = 0.006$**
General Health Perception	−0.101 $P = 0.220$	−0.071 $P = 0.391$

ISS, Injury Severity Score; NISS, New Injury Severity Score; SF-36, Short Form-36.

Table 2 Comparison of MFA score correlation with ISS and NISS (Spearman's rho ranked correlation)

	ISS	NISS
Mobility	0.262 $P = 0.001$	0.299 **$P < 0.001$**
Hand/Fine Motor	–0.208 $P = 0.011$	–0.162 $P = 0.047$
Housework	0.151 $P = 0.066$	0.163 **$P = 0.047$**
Self-care	0.156 $P = 0.057$	0.165 **$P = 0.044$**
Sleep/Rest	0.087 $P = 0.292$	0.078 $P = 0.341$
Leisure/Recreation	0.300 $P < 0.001$	0.299 $P < 0.001$
Family Relationships	0.243 $P = 0.003$	0.239 $P = 0.003$
Cognition/Thinking	0.256 $P = 0.002$	0.312 **$P < 0.001$**
Emotional Adjustment	0.261 $P = 0.001$	0.291 **$P < 0.001$**
Employment/Work	0.333 $P < 0.001$	0.353 **$P < 0.001$**
MFA Total	0.282 $P < 0.001$	0.311 **$P < 0.001$**

ISS, Injury Severity Score; MFA, Musculoskeletal Function Assessment; NISS, New Injury Severity Score.

tion with the outcome score than ISS, the *P*-value is highlighted in bold text.

When using the SF-36, stronger correlations were seen between NISS and psychosocial outcomes than between ISS and the same outcomes, with the exception of Energy and General Health Perception. For Physical Function, Social Function, and Physical Role Limitation, the correlation for both ISS and NISS was at the level of $P < 0.001$. For Emotional Role Limitation, Mental Health, and Pain, the correlations were somewhat more significant for the NISS than for the ISS.

With regard to the MFA, stronger correlations were seen between NISS and psychosocial outcomes than between ISS and the same outcomes, with the exception of Hand/Fine Motor, Sleep/Rest, Leisure/Recreation and Family Relationships. For Employment/Work, and MFA Total, the correlation for both ISS and NISS was at the level of $P < 0.001$, whereas for Mobility, Housework, Self-care, Cognition/Thinking and Emotional Adjustment the correlations were somewhat more significant for the NISS than for the ISS.

Table 3 Comparison of SIP dimension scores correlation with ISS and NISS (Spearman's rho ranked correlation)

	ISS	NISS
Physical Dimension	0.300 $P < 0.001$	0.321 **$P < 0.001$**
Psychological Dimension	0.202 $P = 0.013$	0.230 **$P = 0.005$**
SIP Total	0.322 $P < 0.001$	0.346 **$P < 0.001$**

ISS, Injury Severity Score; NISS, New Injury Severity Score; Sickness Impact Profile.

The SIP showed stronger correlations between NISS and each dimension and the Total Score than between ISS and the same scores. For the Physical Dimension and the Total Score the correlation was at the level of $P < 0.001$ for ISS and NISS, whereas for the Psychosocial Dimension the correlations where somewhat more significant for NISS than for ISS.

Although the differences in correlations seen between the outcomes measures used and ISS and NISS, respectively, were small, there was a consistent trend to better prediction of functional outcome with NISS than with ISS.

Discussion

Although originally introduced to predict survival and mortality after multiple injuries, the ISS has become the most widely used measure of injury severity and has been used in prediction and measurement of outcomes other than death. Its shortcomings with regard to multiple orthopedic injuries [3,6] are corrected largely by the modification of scoring that creates the NISS from the three most severe injuries rather than the three most severely injured body regions [4,7]. In this study of a mixed group of orthopedic trauma, 17% of patients had a NISS that was higher than the ISS. As all of the patients who NISS was higher had an initial ISS of nine or above, a study of only more severely injured patients might be expected to show a greater impact of using NISS over ISS. We wished to examine the effect of using NISS in a heterogeneous group in the first instance.

New Injury Severity Score correlates with physical and psychosocial outcomes scores as used in this study at least as well as the ISS. Although the correlations with improved *P*-values are seen in the psychosocial subscores of the SF-36 and the SIP, stronger correlations are also seen in the physical subscores of each, albeit at the level of $P < 0.001$ for ISS and NISS. With the MFA, NISS better predicts physical function in terms of mobility and ability to perform activities of daily living, as well as cognition and emotional adjustment. The only subscores with which ISS correlated more strongly than NISS was the Hand/Fine Motor, Sleep/Rest and Family Relationship subscores of the MFA.

It is possible that larger differences in functional outcome prediction between ISS and NISS may be found in a study that focuses on patients with multiple injuries only. Our study of 200 patients contained only 34 who had a NISS higher than ISS, and it was not possible to draw meaningful conclusions from analysis of that group in isolation. Our follow-up was just to 6 months, and again longer follow-up studies would be required to assess the final functional outcome, par-

ticularly in patients with multiple injuries. Although many of the differences found between ISS and NISS in terms of correlation with physical and psychosocial outcomes were small, they are nevertheless consistently in the same direction.

Using the statistical methods above, we have shown in this pilot study that the NISS is a somewhat better predictor of functional outcome at 6 months in orthopedic trauma than its predecessor, although this is not what ISS was originally designed for. Both scores, however, correlate significantly with physical and psychosocial outcome as measured by SF-36, SIP, and MFA. Functional outcome after trauma is multifactorial, but both ISS and NISS can be used to provide some useful predictive information. We would not advocate the replacement of ISS with NISS, but as scoring the NISS is a minor modification to the scoring of ISS, using both in parallel in monitoring trauma care could provide extra useful information for minimal extra effort. This enhanced trauma scoring may be useful in the assessment of trauma care delivery within and between centers, with the aim of optimizing overall treatment of patients with musculoskeletal trauma.

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