Comparison of trauma scoring systems for predicting mortality in firearm injuries

Ateşli silah yaralanmalı olgularda mortalite belirlenmesinde skorlama sistemlerinin karşılaştırılması

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BACKGROUND

Prediction of mortality in trauma patients is an important part of trauma care. Trauma scoring systems are the current methods used for prediction of mortality. We aimed to evaluate and compare the performances of Injury Severity Score (ISS) and New Injury Severity Score (NISS) in firearm injuries.

METHODS

Records of 135 firearm-injured patients who applied to Uludag University Emergency Department between January 2001 and December 2005 were analyzed retrospectively. All patients' data, including age, gender, cause of injury, initial vital signs, injury region, Glasgow Coma Scale (GCS), Revised Trauma Score (RTS), mortality, operation data, and final diagnosis, were collected, and ISS, NISS and Trauma and Injury Severity Score (TRISS) were calculated.

RESULTS

Mortality rate was 12.6%. The patients' mean GCS, RTS, ISS, NISS, and TRISS scores were 13.41±0.31, 10.65±0.26, 17.04±1.20, 21.94±1.45, and 9.52±2.37, respectively. The patients were divided into two groups as ISS=NISS (53.3%) and ISS<NISS (46.7%).

CONCLUSION

ISS and NISS both performed well in mortality prediction of firearm injuries. NISS demonstrated no superiority to ISS for prediction of mortality in these patients.

Key Words: Injury Severity Score; New Injury Severity Score; firearm injury; prediction of mortality.

AMAÇ

Travma hastalarında mortalitenin öngörülmesi travma bakımının önemli bir parçasıdır. Günümüzde bu amaçla travma skorlama sistemleri yaygın olarak kullanılmaktadır. Bu çalışmada, ateşli silah yaralanması olan hastalarda yaralanma şiddeti ölçeği (ISS) ve yeni yaralanma şiddeti ölçeği'nin (NISS) mortaliteyi belirlemedeki performanslarının değerlendirilmesi ve karşılaştırılması amaçlandı.

GEREÇ VE YÖNTEM

Uludağ Üniversitesi Hastanesi Acil Servisine Ocak 2001-Aralık 2005 tarihleri arasında başvuran, 135 ateşli silah yaralanmalı olgunun kayıtları geriye dönük olarak incelendi. Tüm hastaların yaş, cinsiyet, oluş şekli, başvuru anındaki vital bulguları, yaralanma bölgeleri, Glasgow koma skalası (GCS) ve revize travma skoru (RTS), mortalite, operasyon bilgileri ve kesin tanıları kaydedildi ve ISS, NISS ve TRISS skorları hesaplandı.

BULGULAR

Mortalite oranı %12,6 idi. Hastaların GCS, RTS, ISS, NISS ve TRISS skorları sırasıyla; 13,41±0,31, 10,65±0,26, 17,04±1,20, 21,94±1,45, 9,52±2,37 olarak saptandı. Hastalar ISS=NISS (%53,3) ve ISS<NISS (%46,7) olarak iki gruba ayrıldı.

SONUÇ

Her iki skorlama sistemi de ateşli silah yaralanmalı hastalarda mortaliteyi öngörmedeki performansı iyidir ve bu hastalarda mortaliteyi belirlemede NISS'nin ISS'ye üstün olmadığı sonucuna varılmıştır.

Anahtar Sözcükler: ISS, NISS, ateşli silah yaralanması, mortalitenin öngörülmesi.

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Trauma scoring systems are indispensable in the management of trauma patients and clinical researches related to trauma. There are several scoring systems for estimating injury severity, mortality and morbidity: Glasgow Coma Scale (GCS), Revised Trauma Score (RTS), the Abbreviated Injury Scale (AIS), Injury Severity Score (ISS), and Trauma and Injury Severity Score (TRISS) are among the most well known.

AIS, ISS and NISS are anatomical, GCS and RTS are physiological scoring systems and TRISS is a combined scoring system.[1] AIS scores every injury and classifies each according to six severity scores as (1) minor, (2) mild, (3) serious, (4) severe, (5) critical, and (6) mortal. The ISS has been used for anatomical severity scoring since it was introduced in 1974. The ISS is the sum of the square of the three most severe injuries, but it only considers one injury per body region.[2] The ISS fails by neglecting other injuries except more severe injuries of whole body regions; moreover, it ignores an equivalently severe injury in the same body region. Therefore, Osler et al.[3] introduced in 1997 a modification of the ISS, termed the New Injury Severity Score (NISS). The NISS is defined as the sum of a patient's three most severe injuries, regardless of body region. TRISS determines probability of survival from the data derived using ISS, RTS and age.[4]

Many comparisons have been made of ISS and NISS in blunt injuries in previous studies; however, only a few have compared these scoring systems in penetrating injuries, and even fewer have compared results in firearm injuries. We thus aimed to evaluate ISS and NISS in firearm injuries by comparing mortality prediction and values for different body regions.

MATERIALS AND METHODS

The study was conducted in a university hospital with an emergency medicine residency program and a volume of over 25,000 annual visits. The hospital is located in Bursa, which is the fourth largest city of Turkey, with a population of around 1.8 million. It is the only hospital with Level I trauma center facilities in the South Marmara region.

Registry data of 135 firearm injury patients who applied to the Emergency Department between January 1, 2001 and December 31, 2005 were retrospectively analyzed. The patients' management, resuscitation and diagnosis were performed by Advanced Trauma Life Support (ATLS).[5] The patients' age, sex, cause of injury (accidental, suicide), initial vital signs, blood transfusion data, injury region, hospitalization data (clinic and time of stay), GCS and RTS scores, mortality, operation data, and final diagnosis were collected from trauma charts and patient files. We divided the patients into two groups on the basis of whether the ISS and NISS were concordant (ISS=NISS) or discordant (ISS<NISS). ISS, NISS and TRISS were calculated and compared for each case in these two groups.

Statistical analysis was performed using SPSS 10.0 version for Windows (SPSS, Chicago, IL, USA). Continuous and categorical variables were presented as the mean (±standard deviation) and frequency values (n, %). After the normality test was performed, the Student's t-test and the Mann-Whitney U test were used for comparison of the distributions of continuous variables between groups. Pearson chi-square test and the two sample Kolmogorov-Smirnov test were used for the comparison of the distributions of categorical variables between groups. The sensitivities, specificities, positive predictive values, positive likelihood ratios, and area under curves of ISS and NISS were calculated using receiver operating characteristic (ROC) analysis for mortality. The ROC statistic is a general measure of the power of a test to separate two mutually exclusive subpopulations. It is defined as the area under the graph of sensitivity × 1 minus specificity. A ROC value of 1 corresponds to a test that perfectly separates two subpopulations, whereas a ROC value of 0.5 corresponds to a test that performs no better than chance. The best value for balancing the sensitivity and specificity of the variable is represented by the point on the curve closest to the upper left hand corner accepted cutoff point. The cutoff values were determined using the MedCalc demo program. In the ROC report generated by the MedCalc demo program, the cutoff value corresponding to the highest accuracy (minimal false-negative and false-positive results) is indicated by a sign. The determination of the risk of mortality, ISS and NISS has been estimated by multivariate logistic regression analysis (Forward LR) with hierarchical models, and Hosmer-Lemeshow (HL) goodness of fit statistics were also performed. The HL statistic measures the calibration of a test (in this case, calibration of the ISS and the NISS); a value of p=0.05 suggests an evenly calibrated test. A more evenly calibrated test is more applicable to all ranges of injury severity. All statistical analyses were performed according to two-sided hypothesis tests, and a p-value of less than 0.05 was regarded as a statistically significant difference.

RESULTS

Between January 1, 2001 and December 31, 2005, a total of 5425 patients were entered into the trauma registry, and of these, 135 (2.5%) were firearm injuries. The mean age of these 135 patients included in the study was 34.54±1 (9-69) with 11% (n=15) female and 89% (n=120) male. The patients' sex, mean age, mortality rate, and average values of RTS, GCS, ISS, NISS and TRISS are shown in Table 1. The mortality rate was 12.6% (8 of these patients died in emergency and 9 after hospitalization). Ninety-seven of the patients (72%) were hospitalized, 23 (17%) were transferred to another hospital, 7 (5%) were discharged from the Emergency Department and 8 (6%) died while in emergency. Average hospitalization time was 9.09 ± 1.27 days. Seventy-nine (58.5%) patients were operated. 80.7% of injuries were intentional, 9.6% were suicides and 9.6% were accidental (Fig. 1).

Seventy-two (53.3%) cases were in the ISS=NISS group and 63 (46.7%) in the ISS<NISS group. There was no significant difference in age, sex, operation

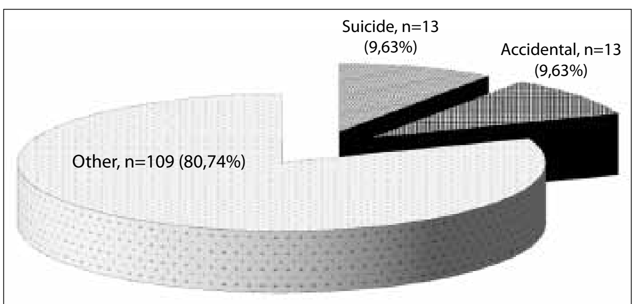

Fig. 1. Distribution of injury types.

Table 1. Main characteristics of firearm-injured patients

Age (mean ± SD)	34.54 ± 1.01
Sex (%)	
Male	88.9% (n=120)
Female	11.1% (n=15)
Region (%)	
Head-neck	25.2% (n=34)
Face	15.6% (n=21)
Thorax	9.6% (n=13)
Abdomen	16.3% (n=22)
Extremity	65.9% (n=89)
External	68.9% (n=93)
Trauma scores (mean ± SD, median)	
GCS	13.41±0.31, 15
RTS	10.65±0.26, 12
ISS	17.04±1.20, 13
NISS	21.94±1.45, 18
TRISS	9.52±2.37, 0
Mortality rate (%)	12.6% (n=17)

data (operated or not) and injury cause (suicide, accidental, other) between the two groups; however, systolic blood pressure, GCS and RTS were significantly lower in the ISS<NISS group (p<0.05). Hospitalization time was lower in the ISS=NISS group (Table 2). The mortality rate of the ISS<NISS group was 20.6% and of the ISS=NISS group was 5.6% (p=0.008) (Fig. 2).

The rate of head and neck injuries in the ISS<NISS group (61.8%) was significantly higher than in the ISS=NISS group (38.2%) (p=0.041) (Table 2). Injury localization distribution is shown in Figure 3.

GCS and RTS scores were significantly lower in deceased patients (p<0.001) and ISS, NISS and TRISS scores were significantly higher in deceased patients (p<0.001) (Table 3).

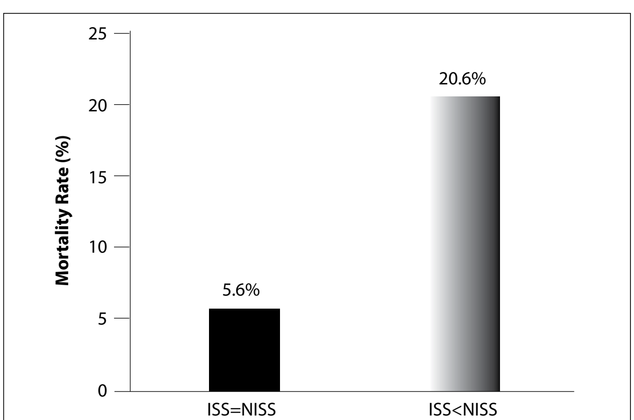

Fig. 2. Mortality rates in ISS=NISS and ISS<NISS groups.

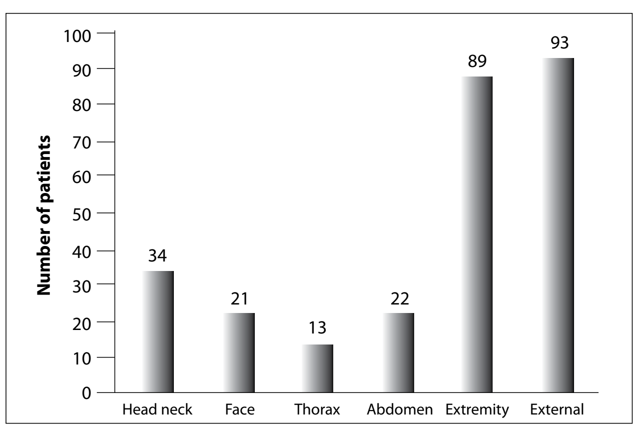

Fig. 3. Distribution of injury regions.

Table 2. Demographic data of cases in the ISS=NISS and ISS<NISS groups

	ISS=NISS	ISS<NISS	p
Age (mean±SD)	33.42±1.34	35.85±1.52	0.233
Sex (M/F) (%/n)	8/64 (88.9%/11.1)	7/56 (88.9%/11.1)	0.609
Systolic P (mean±SD)	115.41±4.68	102.06±4.59	0.045*
Mortality	5.6% (n=4)	20.6% (n=13)	0.008*
Region			
Head-neck (n=34)	13 (38.2%)	21 (61.8%)	0.041*
Face (n=21)	8 (38.1%)	13 (61.9%)	0.128
Thorax (n=13)	5 (38.5%)	8 (61.5%)	0.258
Abdomen (n=22)	9 (40.9%)	13 (59.1%)	0.202
Extremity (n=89)	51 (57.3%)	38 (42.7%)	0.198
External (n=93)	52 (55.9%)	41 (44.1%)	0.371
Trauma scores (mean)(median)			
GCS	14.31 (15)	12.38 (15)	<0.01*
RTS	11.22 (12)	10.01 (12)	<0.01*
Mean hospitalization time (days)	8.73	9.4	0.207

The cutoff value of ISS and NISS for predicting mortality was 20.0 (AUC: 0.964, sensitivity: 94.1%, specificity 89.8%) and 36.0 (AUC: 0.980, sensitivity: 94.1%, specificity: 94.9%), respectively. There were no significant differences in ROC comparison between ISS and NISS scoring systems (Fig. 4). Hosmer-Lemeshow (HL) test was found as ℵ² = 1.908, p=0.965 for ISS and ℵ²=1.400, p=0.994 for NISS. The HL statistic showed equal calibration of the NISS compared with the ISS (p=0.994 vs p=0.965, respectively).

DISCUSSION

The ISS has been used in trauma epidemiology for many years. NISS was improved because of limitations of the ISS, but its use is not as widespread as with ISS. There are several articles in terms of mortality prediction of ISS and NISS. NISS has been found more effective especially for severe trauma in certain studies;[6-10] however, some specialists have shown no preeminence between ISS and NISS.[11-14] Sullivan et al.[8] showed that ISS and NISS were superior for predicting mortality in penetrating and blunt pediatric trauma patients separately. However, the subgroups of penetrating trauma cases (firearm injury, knife injury) have never been analyzed before. In this study, we investigated only firearm injuries and determined that both ISS and NISS have good performance in mortality prediction.

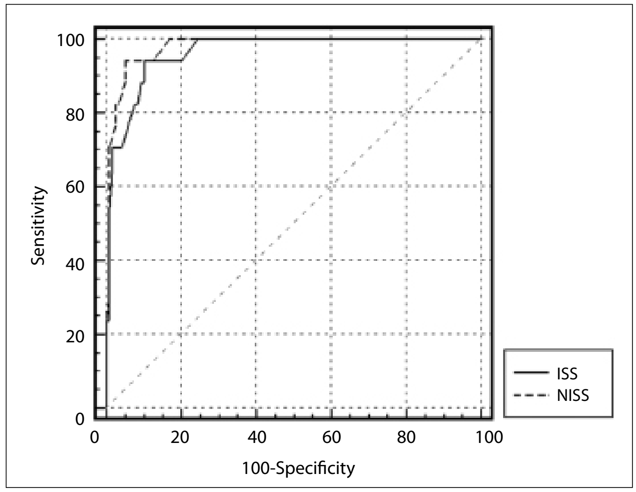

Fig. 4. Comparison of ROC curves of ISS and NISS for mortality prediction.

In several studies, groups were designed as ISS=NISS and ISS<NISS, and mortality prediction was compared between these groups.[8-14] While in some of these studies, researchers found no difference between the groups, some supported the superiority of the ISS<NISS group for mortality prediction. Sullivan et al.[8] showed a similar performance of ISS and NISS in predicting mortality in pediatric trauma patients who were not severely injured, but NISS performed significantly better in predicting mortality in those severely injured. Grisoni et al.[14] noted the equivalence in mortality prediction of ISS and NISS in severe pediatric trauma patients, in contradiction to Sullivan's study. Jamulitrat et al.[9] enunciated that NISS is better than ISS in prediction of mortality in their prospective study in 2044 trauma patients. In another study conducted by Husum et al.,[15] NISS and ISS were compared for prediction of short-term mor-

Table 3. Comparison of age and trauma scores in living and deceased cases

	Living (n=118)	Deceased (n=17)	p
Age (mean, SD, median)	34.5, 1.07, 32.5	34.1, 3.04, 31.5	>0.05
GCS (mean, median)	14.6, 15.0	5.0, 3.0	<0.001*
RTS (mean, median)	11.6, 12.0	3.6, 3.0	<0.001*
ISS (mean, median)	13.3, 13.0	42.5, 36.0	<0.001*
NISS (mean, median)	17.1, 16.5	55.0, 52.0	<0.001*
TRISS (mean, median)	0.34, 0.0	73.2, 91.4	<0.001*

tality and postoperative complications in adult penetrating trauma patients. According to the results of that study, performances of ISS and NISS for short-term mortality prediction were similar, but NISS was superior for prediction of postoperative complications. In our study, we determined that ISS and NISS performed similarly for mortality prediction.

Penetrating injuries differ from blunt injuries, owing to the structure of tissue damage, physiological responses and primary treatment. Furthermore, NISS may predict injury severity better than ISS, due to differences in calculation of these scoring systems. Firearm injury of the thorax or abdomen may cause multiple serious injuries in one region; therefore, the NISS would be more effective for penetrating injuries.[16] Studies comparing NISS and ISS in penetrating injuries are insufficient, and there are even fewer studies about firearm injuries. Husum et al.[15] stated that NISS does not perform better than ISS in their study evaluating victims of penetrating injuries by firearms and land mines. However, that study was done on a low-risk population with low injury severity, with a mean ISS of 8 and mean NISS of 10, and the authors stressed that the results should not be extrapolated to high-severity injuries. In the present study, we evaluated high-severity trauma patients, with a mean ISS of 17.04±1.2 and mean NISS of 21.94±1.45, and found no superiority between these scoring systems. In the same study done by Husum et al., prediction of mortality was compared in injured body regions divided into groups as head, torso and abdomen. While NISS performed better in torso and abdominal injuries, ISS was superior in head injuries. In our present study, we found no significant differences concerning mortality between head and neck, face, thorax, abdomen and extremity injuries.

Streng et al.[17] defined that both NISS and ISS performed similarly good concerning morbidity and hospitalization time in 199 patients with firearm injuries localized to the abdomen and thorax. In our study, there was no significant difference between ISS<NISS and ISS=NISS groups with respect to hospitalization time; on the other hand, the mortality rate was significantly higher in the ISS<NISS group (p=0.008).

In another study presented by Tay et al.[13] comparing NISS and ISS for mortality prediction in both blunt and penetrating (22.9% firearm injuries) trauma patients, they found that these scoring systems performed similarly in both penetrating and blunt injuries, congruent to our results.

Several studies have compared the NISS to the ISS with respect to mortality.[8-14] Some of these studies have reported contradictory results, but have generally found the NISS to be equivalent to the ISS in populations with low injury severity.[8-11] However, the NISS appears to perform significantly better than the ISS in populations with moderate to severe injury severity, in which there is a discrepancy between ISS and NISS (ISS<NISS).[12-14] The most important reason for the contradictory results may be differences in the studied populations (such as type and severity of injury and site of injury). This may have accounted for the higher mortality rates in the ISS<NISS group compared to the ISS=NISS group in our study. Furthermore, the ISS<NISS group reflects moderate and severe injured patients, and mortality rates are higher in this group as expected. On the other hand, a limitation of our study was the low number of patients available for the NISS and ISS comparisons.

In conclusion, as presented in this article, many previous studies have been conducted to compare the various trauma scoring systems, especially NISS and ISS, in blunt and penetrating trauma patients. However, there are few studies about the subgroups of these injuries. Given the differences in the management of firearm and knife injuries, it will be useful to work on these subgroups. According to the results of our study, both ISS and NISS can be useful in mortality prediction in firearm-injured patients. However, it is apparent that further studies are needed with wider study groups to detect the superior scoring system for penetrating injuries.

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