BRIEF ORIGINAL

Classification of the severe trauma patient with the Abbreviated Injury Scale: degree of correlation between versions 98 and 2005 (2008 update)

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Objectives. To explore differences in severity classifications according to 2 versions of the Abbreviated Injury Scale (AIS): version 2005 (the 2008 update) and the earlier version 98. To determine whether possible differences might have an impact on identifying severe trauma patients.

Methods. Descriptive study and cross-sectional analysis of a case series of patients admitted to two spanish hospitals with out-of-hospital injuries between February 2012 and February 2013. For each patient we calculated the Injury Severity Score (ISS), the New Injury Severity Score (NISS), and the AIS scores according to versions 98 and 2005.

Results. The sample included 699 cases. The mean Severity (SD) age of patients was 52.7 (29.2) years, and 388 (55.5%) were males. Version 98 of the AIS correlated more strongly with both the ISS (2.6%) and the NISS (2.9%).

Conclusion. The 2008 update of the AIS (version 2005) classified fewer trauma patients than version 98 at the severity levels indicated by the ISS and NISS.

Keywords: Abbreviated Injury Scale. Trauma severity indices. Trauma severity scores. Severity. Clinical coding.

Grado de correlación entre las versiones 98 y 2005 (actualización 2008) de la Abbreviated Injury Scale (AIS) en la categorización del paciente traumatológico grave

Objetivos. Estudiar si existen diferencias en la asignación de gravedad entre las versiones 98 y 2005 –actualización 2008– de la escala Abbreviated Injury Scale (AIS) y determinar si estas posibles diferencias podrían tener repercusión en la definición de paciente traumatológico grave.

Método. Estudio descriptivo de una serie de casos con análisis transversal que incluyó a pacientes ingresados por lesiones debidas a causas externas en dos hospitales españoles, llevado a cabo entre febrero de 2012 y febrero de 2013. Se calculó el Injury Severity Score (ISS) y el New Injury Severity Score (NISS) de cada uno de los casos con ambas versiones de la escala AIS.

Resultados. La muestra estuvo compuesta por 699 casos, con una edad media de 52,7 (DE 29,2) años, de los cuales 388 (55,5%) fueron varones. Se obtuvo una mayor clasificación de pacientes graves con la versión AIS 98, tanto para el ISS (2,6%) como el NISS (2,9%).

Conclusiones. La versión AIS 2005 –actualización 2008– clasifica un menor número de pacientes como graves en comparación con la versión AIS 98.

Palabras clave: Escala Resumida de Traumatismos. Índices de Gravedad del Trauma. Puntaje de Gravedad del Traumatismo. Gravedad del Paciente. Codificación Clínica.

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Introduction

The Abbreviated Injury Scale (AIS) is the most widespread injury severity measurement scale in the world[1-4]. The AIS measures the severity of injuries in isolation. To measure the overall severity of an individual with several injuries, the Injury Severity Score (ISS) and New Injury Severity Score (NISS) were developed based on the AIS[4]. When the severity of injuries is determined, an ISS score greater than 15 of the index defines the serious trauma[5,6], independently of the AIS version used for its calculation, and constitutes the criterion for the inclusion of patients in registries or other research studies. The World Health Organization, in its report on road safety in 2009, urges the definition of the serious patient and the gathering of all data[7]. For this reason, the European Union, in 2013, required member countries to report all cases of serious trauma patients. In this sense, the version used of the scale to report the severity of the injuries could influence the classification of a serious trauma patient. For this reason, the objectives of the present study were to study if there were differences in the allocation of severity between versions 98 and 2005 -update 2008- of the AIS scale and to determine if the possible differences between both versions of the scale would have an impact on the definition of a serious traumatic patient.

Method

Descriptive study of a series of cases with a cross-sectional analysis carried out at the Marqués de Valdecilla University Hospital of Cantabria (HUMV) and the Hospital Complex of Navarra (CHN) from February 2012 to February 2013. The study was approved by the Committee Research Ethics of the HUMV. The inclusion criteria were all patients with injuries caused by external causes admitted to the traumatology service through the emergency service (ED). The exclusion criteria were: 1) the admission was not through the SU or it was a re-entry for the same reason; 2) injuries with unknown severity and 3) inability to review the medical history.

A necessary sample size of 360 patients was calculated for the HUMV and 390 patients for the CHN from a target population of 1,116 cases in the HUMV and of 1,713 in the CHN, with a deviation of 1.96, a margin of error of 5%, a proportion of 50%, and a possible loss of 10%. For the selection of the sample, a random sampling without replacement was carried out by computer application to generate random numbers, so that no case was selected more than once.

The assignment of the severity of the injuries was carried out by manual coding from March 2013 to September 2014, by a specialist in AIS, certified by the Association for the Advancement of Automotive Medicine (AAAM) and member of the International Committee of Certification in AIS. The ISS and NISS were calculated for each of the cases with both versions of the AIS. The AIS classifies each lesion, according to the region of the body according to its relative importance, on an ordinal scale of 6 points where 1 is the lowest possible severity and 6 is the maximum severity[4]. The main changes produced in the AIS 2005 version -update 2008- with respect to the AIS 98 version are shown in Table 1.

However, to measure the overall severity of an individual with multiple injuries, the ISS and NISS indices were developed. The ISS is the sum of the squares of the 3 most severe AIS in 3 different body regions (ISS = $A^2 + B^2 + C^2$), that is, A, B, and C represent the three most severely injured body regions. The NISS is calculated from the sum of the squares of the 3 highest AIS, regardless of the body region[4]. The range of values is between 1 and 75 (lower and higher severity, respectively). The ISS and NISS variables were categorized into: 1) mild (1-8); 2) moderate (9-14); 3) serious (16-24), and 4) very serious (> 24)[8].

For the descriptive analysis we used means, standard deviations, frequencies and percentages. Contingency tables were generated to compare the ISS and NISS scores in both versions of the scale, using McNemar-Bowker's χ^2 test for polytomous categorical variables. To analyze the agreement and concordance between the ISS and NISS scores between the 2 versions of the AIS, the intraclass correlation coefficient (ICC) and the quadratic-weighted kappa (K) coefficient of Cohen[9,10] were used. Following the classification proposed by Landis and Koch[10], a $\kappa > 0.75$ was established as an excellent agreement, between 0.75 and 0.40 good and < 0.40 poor degree of agreement. For the interpretation of the ICC, the classification established by the same authors was followed, according to which a ICC > 0.90 indicates a very good concordance; 0.71-0.90, good; 0.51-0.70, moderate; 0.31-0.50, median, and < 0.31, poor. The statistical package IBM SPSS version 22 was used for the statistical analysis.

Results

Of the 749 cases reviewed, 2 were excluded due to inability to visualize the history and 48 because they did not meet selection criteria. Finally, 699 cases were included: 344 (49.3%) came from the HUMV and 355 (50.7%) from the CHN. Table 2 shows the demographic characteristics, etiology of the lesions and the categories of the ISS and NISS indexes according to the different versions of the AIS. When analysing the values of the ISS and NISS indices, a greater number of patients was observed in the AIS 2005 version -update 2008- for the category of the values 1-8, and a greater number

Table 1. Main changes introduced in the 2005 AIS version 2008 update with respect to the AIS 984 version[4]

Injury codes	• 11,331 *versus* 2,104.
Lesion mechanisms	• New injury mechanisms are introduced (example: drowning, freezing, hypothermia, explosion type injury).
Lesional descriptors	• Descriptors such as "displaced fracture", "closed fracture", etc. are eliminated. • The descriptors are adapted to the current medical terminology; new descriptors are included for injuries such as "bilateral"; more detailed criteria for injury sizes are added; descriptions of injuries are extended (example: eye injuries and facial fractures); the specificity of the lesions is increased, especially the orthopedic lesions.
Injuries	• Injuries such as concussion or loss of consciousness are diagnosed to diagnose some injuries; the association of certain injuries such as fractures associated with heme / pneumothorax is eliminated. • Specific concussion injuries are added; it goes much deeper in injuries such as diffuse axonal injury; new injuries are added (example: crush injuries and the specificity of many injuries such as amputations, certain nerve, ligamentous, bony lesions, etc.) is increased.
Specific changes in coding	• The coding of bone lesions is changed according to the location, articular involvement and complexity of the fracture. • The coding of pelvic fractures is changed to go from coding all pelvic fractures, to assign a single code for all fractures depending on the stability of the pelvic ring regardless of the number of fractures. • Coding of the rib cage is changed and coding of the rib fractures together with possible hemo/pneumo thorax and the costal volet as an independent lesion.
Changes in the severity code	• The severity code is changed in more than 200 codes, mainly in the head, extremities and thorax. In some cases increasing the severity code and in most cases decreasing the severity code. Changes based on the clinical demonstration of the relative severity of the injuries

AIS: *Abbreviated Injure Scale.*

Tabla 2. Characteristics of the study patients

	Total N = 699 n (%)	HUMV N = 344 n (%)	CHN N = 355 n (%)	p
Age [Mean (SD)]	52.7 (29.2)	53.2 (29.2)	52.2 (29.3)	0.82
Sex				0.21
Male	388 (55.5)	198 (57.7)	190 (53.5)	
Female	311 (44.4)	146 (42.3	165 (46.5)	
Injuries				0.142
Falls	422 (60.4)	209 (60.9)	213 (60.0)	
Traffic accidents	83 (11.9)	52 (15.1)	31 (8.7)	
Blows, crushes and traumatic contacts	112 (16.0)	46 (13.3)	66 (18.6)	
Unknown	49 (7.0)	23 (6.7)	26 (7.3)	
Aggressions	16 (2.3)	6 (1.7)	10 (2.8)	
Self-inflicted injury	6 (0.9)	3 (0.9)	3 (0.8)	
Exposure to liquids, gases or hot objects	3 (0.4)	–	3 (0.8)	
Shooting and explosions	2 (0.3)	1 (0.3)	1 (0.3)	
Bites	2 (0.3)	1 (0.3)	1 (0.3)	
Respiratory obstruction	2 (0.3)	1 (0.3)	1 (0.3)	
Exposure to electricity, radiation and heat	2 (0.3)	2 (0.6)	–	
ISS 98				< 0.001
4 categories				
1-8	341 (48.8)	131 (38.1)	210 (59.2)	
9-14	292 (41.8)	158 (45.9)	134 (37.7)	
16-24	33 (4.7)	26 (7.6)	7 (2.0)	
> 24	32 (4.6)	29 (8.4)	3 (0.8)	
2 categories				
≤ 15	634 (90.7)	289 (84.0)	345 (97.2)	
≥ 15	65 (9.3)	55 (16.0)	10 (2.8)	
ISS 2005 (2008)				< 0.001
4 categories				
1-8	398 (56.9)	166 (48.3)	232 (65.4)	
9-14	254 (36.3)	139 (40.4)	115 (32.4)	
16-24	19 (2.7)	14 (4.1)	5 (1.4)	
> 24	28 (4.0)	25 (7.3)	3 (0.8)	
2 categories				
≤ 15	652 (93.3)	305 (88.7)	347 (97.7)	
≥ 15	47 (6.7)	39 (11.3)	8 (2.3)	
NISS 98				< 0.001
4 categories				
1-8	321 (45.9)	122 (35.5)	199 (56.1)	
9-14	284 (40.6)	148 (43)	136 (38.3)	
16-24	44 (6.3)	29 (8.4)	15 (4.2)	
> 24	49 (7.0)	45 (13.1)	4 (1.1)	
2 categories				
≤ 15	606 (86.7)	270 (78.5)	336 (94.6)	
≥ 15	93 (13.3)	74 (21.5)	19 (5.4)	
NISS 2005 (2008)				< 0.001
4 categories				
1-8	372 (53.2)	153 (44.5)	219 (61.7)	
9-14	254 (36.3)	132 (38.4)	122 (34.4)	
16-24	36 (5.2)	27 (7.8)	9 (2.5)	
> 24	37 (5.3)	32 (9.3)	5 (1.4)	
2 categories				
≤ 15	626 (89.6)	285 (82.5)	341 (96.1)	
≥ 15	73 (10.4)	59 (17.2)	14 (3.9)	

HUMV: Hospital Universitario Marqués de Valdecilla; CHN: Complejo Hospitalario de Navarra; ISS: Injury Severity Score. NISS: New Injury Severity Score.

of patients for the categories of the values 9 -14, 16-24 and > 24 in the AIS 98 version. When comparing the ISS categories between both versions, 602 (86.2%) pairs were concordant (McNemar-Bowke $\chi^2 = 61.1$, $p < 0.001$), obtaining K indices of 0.87 (95% CI 0.81-0.93, p = 0.031) and ICC of 0.93 (95% CI 0.92-0.95, $p < 0.001$). This caused that in 18 patients there was a change in the criterion of a serious patient. When comparing the NISS categories between both versions, 598 (85.7%) pairs were concordant (McNemar-Bowke's $\chi^2 = 53.8$, $p < 0.001$), obtaining K concordance rates of 0.87 (95% CI 0.82-0.92, p = 0.026), (0.816, 0.919) and ICC of 0.92 (95% CI 0.92-0.94, $p < 0.001$). In this way, the criterion of severe patient was changed in 20 patients (Tables 3 and 4).

Table 3. Contingency table of the ISS levels of both versions of the scale

	ISS 2005 (2008)				
ISS 98	1-8	9-14	16-24	> 24	Total
1-8	336	5	0	0	341
9-14	61	227	3	1	292
16-24	0	19	13	1	33
> 24	0	3	3	26	32
Total	**397**	**254**	**19**	**28**	**698**

ISS: Injury Severity Score.
χ^2 de McNemar-Bowke $p < 0,001$.
Concurrent pairs = 602 (86.2%); ISS cases 2005 (2008) lower than ISS 98 = 86 (12.3%); ISS 05 cases higher than ISS 98 = 10 (1.4%); cases that moved to < 15 with ISS 2005 (2008) = 22 (3.1%); cases that moved to > 15 with ISS 2005 (2008) = 4 (0.6%).

Table 4. Contingency table of the NISS levels of both versions of the scale

	ISS 2005 (2008)				
NISS 98	1-8	9-14	16-24	> 24	Total
1-8	315	6	0	0	321
9-14	48	232	4	0	284
16-24	8	14	18	4	44
> 24	0	2	14	33	49
Total	**371**	**254**	**36**	**37**	**698**

NISS: New Injury Severity Score.
χ^2 de McNemar-Bowke $p < 0,001$.
Matching pairs = 598 (85.7%); NISS 2005 cases (2008) lower than ISS 98 = 86 (12.3%); NISS 05 cases higher than ISS 98 = 14 (2%); cases that moved to < 15 with NISS 2005 (2008) = 24 (3.4%); cases that moved to > 15 with NISS 2005 (2008) = 4 (0.6%).

Discussion

The results of the present study show that there was a percentage of 2.6% for the ISS and 2.9% for the NISS of patients classified as less severe by the AIS 2005 -update 2008- compared to the AIS 98. These results coincide with similar studies that also found a greater number of patients serious for the AIS 98 version compared to the AIS 2005 version -update 2008-[8,11-14].

The NISS values are, in general, higher than those of the ISS in both versions of the scale, since the three most serious injuries are used for its calculation, regardless of the body region in which they are located. The ISS counts only the three most serious injuries of up to three different body regions, which can mean the loss of relevant information, especially in cases with several injuries in the same body region. Other authors who studied the differences of the values of the ISS and NISS for the same cases, obtained the same results[12-15].

The severity of the lesions is one of the indicators

used in the calculation of health costs associated with injuries in traumatic patients and the selection criterion for a serious patient is defined as that with an ISS score greater than 15. Some authors[6,13,14] have suggested updating this definition by modifying the cut-off point between 12 and 14. In our study, an ISS greater than 12 for the 2005 AIS-2008 update-classified the same percentage of serious patients as an ISS greater than 15 for the AIS 98.

The study presented a number of limitations. In first instead, the column of the AIS 2005 dictionary - 2008 update - which shows the correspondence of the AIS 98 codes for each 2005 AIS code - 2008 update - was eliminated to avoid a bias in the coding. Second, given the known absence of an extra-accredited Spanish-language encoder as an AIS specialist, a manual double coding could not be performed to check the intercoder reliability. Lastly, despite having carried out random sampling without replacement, it was possible to make a selection bias of the sample due to the characteristics of the selected hospital centers.

In conclusion, we can affirm that the use of the AIS 2005 version - 2008 update - originates a decrease in the number of trauma patients classified as serious compared to the AIS 98 version. This fact could force to rethink the definition of a serious patient in function of the different versions of the scale. Future studies will be necessary to establish a cut-off point adapted to the new times.

Conflicting interests

The authors declare no conflict of interest in relation to this article.

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Ethical Responsibilitiess

The Clinical Research Ethics Committee of the Marqués de Valdecilla University Hospital of Cantabria evaluated and approved the study.

All authors have confirmed the maintenance of confidentiality and respect for patients' rights in the author's responsibilities document, publication agreement and assignment of rights to EMERGENCIAS.

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