ORIGINAL ARTICLE

Mortality in severe trauma patients attended by emergency services in Navarre, Spain: validation of a new prediction model and comparison with the Revised Injury Severity Classification Score II

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Objective. To validate the Mortality Prediction Model of Navarre (MPMN) to predict death after severe trauma and compare it to the Revised Injury Severity Classification Score II (RISCII).

Methods. Retrospective analysis of a cohort of severe trauma patients (New Injury Severity Score >15) who were attended by emergency services in the Spanish autonomous community of Navarre between 2013 and 2015. The outcome variable was 30-day all-cause mortality. Risk was calculated with the MPMN and the RISCII. The performance of each model was assessed with the area under the receiver operating characteristic (ROC) curve and precision with respect to observed mortality. Calibration was assessed with the Hosmer-Lemeshow test.

Results. We included 516 patients. The mean (SD) age was 56 (23) years, and 363 (70%) were males. Ninety patients (17.4%) died within 30 days. The 30-day mortality rates predicted by the MPMN and RISCII were 16.4% and 15.4%, respectively. The areas under the ROC curves were 0.925 (95% CI, 0.902–0.952) for the MPMN and 0.941 (95% CI, 0.921–0.962) for the RISCII (*P*=0.269, DeLong test). Calibration statistics were 13.6 (*P*=.09) for the MPMN and 8.9 (*P*=.35) for the RISCII.

Conclusions. Both the MPMN and the RISCII show good ability to discriminate risk and predict 30-day all-cause mortality in severe trauma patients.

Keywords: Trauma. Risk models. Quality of trauma care. Mortality.

Validación del Modelo de Predicción de Mortalidad de Navarra y comparación con el Revised Injury Severity Classification Score II en los pacientes con traumatismo grave atendidos por el Sistema de Emergencias de Navarra

Objetivo. Validar el Modelo de Predicción de Mortalidad de Navarra (MPMN), y compararlo con el Revised Injury Severity Classification Score II (RISC II) para predecir la mortalidad en los pacientes con traumatismo grave (PTG).

Método. Estudio analítico de cohorte retrospectivo de PTG (New Injury Severity Score –NISS– >15 puntos) atendidos por el Sistema de Emergencias de Navarra entre 2013-2015. La variable resultado fue la mortalidad por cualquier causa a los 30 días. Se calcularon los modelos de riesgo MPMN y RISC II. El rendimiento de los modelos se evaluó con la curva característica operativa del receptor (COR) y el área bajo la curva (ABC), la precisión con la mortalidad observada y predicha, y la calibración con la prueba de Hosmer-Lemeshow.

Resultados. Se incluyeron 516 pacientes con una edad media de 56 (DE 23) años, de los cuales 363 (70%) fueron varones. Noventa (17,4%) pacientes fallecieron a los 30 días. La mortalidad a 30 días predicha para el modelo MPMN y RISC II fue de un 16,4% y 15,4%, respectivamente. El ABC de la COR para el modelo MPMN fue de 0,925 (IC95% 0,902-0,952) y para el modelo RISC II fue de 0,941 (IC95% 0,921-0,962) (p de DeLong = 0,269). La calibración del modelo MPMN fue de 13,6 (p = 0,09) y del modelo RISC II fue de 8,9 (p = 0,35).

Conclusiones. Los modelos MPMN y RISC II muestran buena capacidad de discriminación para predecir la mortalidad global a los 30 días entre los PTG.

Palabras clave: Trauma. Modelos predictivos. Calidad asistencial al trauma. Mortalidad.

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Introduction

Continuous evaluation by comparing oneself in different periods or with other regional, national or international systems is essential to improve the results in the care of patients with severe trauma (PST)[1]. In this sense, it is essential to have a valid risk model to predict the results[2]. In the last decades, different models have been developed to predict mortality in PST[3]. Of all of them, the Trauma and Injury Severity Score (TRISS) is the most used in the world[4]. It is a risk model that predicts the probability of survival based on variables such as age

(cut-off point ≥ 55 years), the mechanism of injury (penetrating or blunt), physiological parameters, measured by the Revised Trauma Score (RTS), and anatomical, quantified by the Injury Severity Score (ISS)[5]. Initially, the TRISS coefficients were derived from the Major Trauma Outcome Study[4] and, more recently, with data obtained from the National Trauma Data Bank in 2009[5]. However, there is a limitation of applying this TRISS[6-8] methodology to data sets other than that were derived, which has led to the publication of different versions of said scale.

Belzunegui et al. derived, following the recommendations of the Utstein style, the Mortality Prediction Model of Navarra (MPMN)[9] from the data of 378 PST documented in the Registry of Serious Injuries of Navarre (RTG-N) between 2011-2012[9-11]. The MPMN differs from the TRISS in the inclusion of the comorbidity of the patient according to the classification of the American Society of Anesthesiologists Physical Status Classification (ASA-PS), in the use of the New Injury Severity Score (NISS) instead of the ISS, and in the consideration of age as a continuous variable instead of a dichotomous variable[9].

The Registry of the German Society of Traumatology (TR-DGU®), created in 1993 for the documentation of the PST, also used the TRISS initially for intra-hospital comparisons[12]. However, due to its limitations[7,8,13], Lefering introduced the Revised Injury Severity Classification (RISC) model as of 2008 PTG registered between the years 1993-2000[12]. The problem of missing values of the variables for the calculation of the RISC model and the possibility of including other prognostic factors, such as pupillary size and reactivity, led the authors to derive and validate, from more recent data, a new model called RISC II. Although the inclusion of 13 different prognostic variables of the same PTG has improved its predictive capacity with respect to other existing scales, it lacks validation studies in Spain[14].

To date, the MPMN risk model has not been validated, which is a limitation at the time of its implementation in clinical practice[15,16], nor has it been compared with other standardized models, such as the RISC II, in the PST. Therefore, the objective of the present study was to validate the MPMN model and compare it with the RISC II model to predict the 30-day global mortality among the PSTs attended by the Emergency System of Navarra.

Method

Analytical retrospective cohort study that included the RTG-N PST included from 1/1/2013 to 12/31/2015. The study was approved by the Ethics Committee of the Health Department of the Government of Navarra (Pyto 2016/48). The RTG-N is a population-based registry, adapted to the variables and categories defined by the unified style Utstein[10], which includes PST injured by external agents of any intentionality with a NISS value greater than 15 points served by the System of Emergency of Navarra. Excluded are those whose admission to the hospital occurs more than 24 hours after suffering the injury, those injured by asphyxiation or immersion, hanging or burned who do not have other traumatic injuries and those who did not consent to participate in the study[11]. For the present study, we also excluded those cases in which data were not available for the calculation of the MPMN model and the RISC II, as well as the vital status at 30 days after the index episode.

We collected demographic data (age and sex), comorbidity (ASA-PS), type of accident (blunt or penetrating), the mechanism (motor vehicle, motorcycle, bicycle, run over, other traffic-related, firearm, knife, various objects, low energy fall, high energy drop), sanitary transport (helicopter, medicalized or conventional ambulance, private vehicle or others), prehospital intubation, prehospital cardiorespiratory arrest, anatomical and physiological indices both hospital and prehospital [Glasgow Coma Scale (GCS), respiratory rate, systolic blood pressure, RTS, Triage RTS (T-RTS), ISS, NISS and Head, Face, Thoracic, Abdominal, Extremity and Pelvic Rings with Abbreviated Injury Scale (AIS) > 2 points], the laboratory data [haemoglobin, International Normalized Ratio (INR), base deficit], and the length of hospital stay The data were supervised by a researcher who verified compliance with the selection criteria and verified the completion of the variables to avoid lost values. A 30-day follow-up after the traumatic event was performed to document mortality from any cause through a telephone call or consultation of the unique computer history of the Community of Navarra.

The survival probability model based on the MPMN was calculated from the following logistic regression equation: Logit (p) = -5.72 + 0.074 x Age + 0.133 x NISS + 0.922 x Comorbidity (if moderate/severe systemic disease) according to the ASAPS classification) - 0,726 x hospital RTS. This model takes age, NISS and RTS as continuous variables, and comorbidity in two categories: healthy / mild systemic disease (value 0) and moderate / severe systemic disease according to the ASA-PS classification (value 1)[9]. The calculation of the RISC II model was also based on a logistic regression model that includes 13 variables, although it can be calculated whenever the age and severity of the injury measured by the AIS scale is available, since it assigns a value of 0 to the other variables with missing values. The AIS scale codes the injury into six categories: 1) mild; 2) moderate; 3) serious without danger to life; 4) serious with danger to life; 5) criticism; 6) without possibility of survival.

The sample size of 500 PTG allowed assuming an alpha risk of 0.05 and a beta risk of 0.2 in a bilateral contrast to detect a difference equal to or greater than 5%, considering a mortality rate of 20%.

The qualitative variables were presented as absolute numbers and frequencies and the quantitative variables as mean and their standard deviation (SD) or median and their interquartile range (RIC) if the principles of normality were not met. The Chi-square test or Fischer's

exact test for the qualitative variables and the Mann-Whitney U test for the quantitative ones were used for the univariate analysis. A value of $p < 0.05$ was considered statistically significant. The performance of the MPMN and RISC II was evaluated in terms of discrimination, precision and calibration. Discrimination was assessed through the area under the curve (ABC) of the receiver's operating characteristic (ROC). The ABC values were presented with their 95% confidence interval (95% CI). The ABCs of the ROC were compared with the De-Long test. The precision describes the concordance between the observed and expected mortality rate according to the model. The cut-off point established to calculate the predicted mortality was 0.5. The calibration was calculated with the Hosmer-Lemeshow test. Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 21 (IBM Corp, Armonk, NY, USA).

Results

Of the 524 eligible patients, 8 (1.5%) cases were excluded due to lack of data for the calculation of the models. We finally included 516 PTG [mean age of 56 (SD 23) years, 363 (70%) men]. Ninety patients [17.4% (95% CI 14.2-20.7)] died at 30 days. Table 1 shows the characteristics of the patients included in the study and the univariate analysis based on 30-day mortality.

Tables 2 and 3 reflect the variables of the RISC II and MPMN models, respectively, and their application in the RTG-N sample, including information on lost values. The ABC of the ROC for the RISC II was 0.941 (0.921-0, 962) and the ABC of the ROC for the MPMN was 0.927 (0.902-0.952), the differences being not statistically significant ($p = 0.269$) (Figure 1). The predicted mortality, establishing a cutoff point of 0.5, for the MPMN and RISC II model was 16.4% and 15.4%, respectively. Figure 2 shows the observed and expected mortality according to the MPMN and RISC II models. Figure 3 shows the scatter plot where each patient is represented according to the two predicted values of the MPMN model and the RISC II.

Discussion

The present study has shown that RISC II and MPMN are two predictive models that have a good discriminative capacity to predict global mortality at 30 days of PTG.

The MPMN showed a good discrimination capacity (ABC of the ROC of 0.92) similar to that observed by Belzunegui et al. in the derivation study of the model where the ABC of the ROC was 0.93[9]. The accuracy of this model documented an observed mortality of 17.4% against the predicted 16.4%, and an acceptable calibration. In this sense, it is considered that the MPMN model could be a valid risk model that could serve as a comparison to see the evolution of our polytrauma patient care system[9]. The precision of the RISC II showed an observed mortality of 17.4% against the predicted of 15.4% and a good calibration.

When interpreting these results, several aspects should be considered. The inclusion of laboratory values (base deficit and INR) and indirect signs of bleeding (hypotension and hemoglobin) influence the prognosis of PST[14]. The GCS in the RISC II has been replaced by the motor component, since it has been shown to be a better predictor than the scale itself, while in the MPMN the total ECG is still used for the calculation of the RTS[7]. Other variables such as reactivity and pupillary size were also added to the RISC II model based on their prognostic relevance in PST with traumatic brain injury (TBI)[18]. In addition, there is a high prevalence of severe TBI in our casuistry: 58% with AIS greater than 2 in the head. Another important aspect is that the MPMN model underestimates the TBI, thus having a significant impact on the prognosis of the PST given its high prevalence. It is known that a grade 5 AIS lesion in the head has a higher mortality than an AIS lesion of 5 in the thorax or abdomen and in the MPMN model, based on the NISS that is calculated with the AIS lesions, this is not take into account[19]. The RISC II model, on the other hand, considers the two worst injuries with the highest AIS, since these have been shown to predict the result of the PST better than the ISS or the NISS[14] and consider the severity of the TBI, measured according to the AIS scale, as an important additional factor that influences the forecast. In addition, Lefering et al. they used hospital discharge mortality rates for their calculations[14], while our team uses 30-day mortality rates, as recommended by the Utstein style[11]. It is known that in-hospital mortality underestimates mortality in older people after trauma[20].

Other possible reasons that justify the differences found could be due to the inclusion criteria or the different profile of the patients. The criterion for inclusion in the RTG-N was the score higher than 15 for the NISS, while in the study by Lefering et al. It was a score higher than 3 in the ISS[14]. In fact, in this study, the PTG analyzed were more serious than the PTG included in the study conducted by Lefering et al. [NISS = 26.7 (SD 9.6) and ISS = 19.5 (SD 9.0) vs NISS = 24.1 (SD 15.8) and ISS = SD 19.3 (SD 13.1)]. Likewise, the average age of the PTG included in this study was 56 years and the percentage of PST with relevant TBI was 58% while in the study by Lefering et al. the average age of the included patients was 48 years and only 34% had relevant TBI[9].

As we have already mentioned, the calculation of RISC II for a PST requires two essential variables, the age and the anatomical lesion measured by the AIS scale, but logically its predictive capacity increases as the values of the remaining 11 variables are added[21,22]. On the other hand, the calculation of the MPMN model only requires 4 variables (age, RTS, NISS and comorbidity) and the values of these variables are present in almost all of the occasions (in this study, 98.5%). Given

Table 1. Characteristics of patients included in the study and univariate analysis based on overall 30-day mortality

	Global N = 516 n (%)	Deceased N = 90 n (%)	Survivers N = 426 n (%)	P
Age in years [mean (SD)]	56.0 (22.8)	72.2 (18.7)	52.4 (22.1)	< 0.001
Male	363 (70)	54 (60)	309 (73)	
Comorbidity according to ASA-PS classification				< 0.001
1-2	322 (63)	34 (39)	288 (67)	
3	153 (29)	43 (48)	105 (25)	
4	41 (8)	13 (13)	28 (6)	
Type of accident				0.551
Blunt	494 (96)	87 (97)	407 (96)	
Penetrating	22 (4)	3 (3)	19 (4)	
Mechanism				< 0.001
Traffic	182 (35)	19 (21)	163 (38)	
Vehicle with 4 or more wheels	83 (15)	8 (9)	74 (17)	
Motorcycles	35 (7)	1 (1)	34 (8)	
Bicycle	29 (6)	9 (10)	29 (7)	
Run over	35 (7)	1 (1)	26 (6)	
Fall of less than 3 m	194 (38)	54 (60)	140 (33)	
Fall of more than 3 m	65 (12)	8 (9)	57 (13)	
Firearm/Weapon	9 (2)	2 (2)	7 (2)	
Other mechanism *	66 (13)	7 (8)	59 (14)	
Prehospital characteristics				
Cardiorespiratory stop	3 (1)	3 (3)	0 (0)	
Need for intubation	57 (11)	29 (32)	28 (7)	
Vital signs [mean (SD)]				
Glasgow coma scale	13 (3.5)	9 (5.1)	14 (2.6)	< 0.001
Respiratory rate (breaths/minute)	18 (4.9)	17 (4.6)	18 (5.0)	0.185
Systolic blood pressure (mmHg)	127 (22.3)	124 (29.1)	128 (20.7)	< 0.001
Hospital emergency				
Vital signs [mean (SD)]				
Glasgow coma scale	12 (4.3)	8 (5.3)	14 (3.3)	< 0.001
Respiratory rate (breaths/minute)	18 (5.5)	17 (6.6)	18 (5.3)	0.483
Systolic blood pressure (mmHg)	125 (25.7)	109 (32.3)	128 (22.8)	< 0.001
Laboratory values at admission [mean (SD)]				
Hemoglobin (mg/dL)	12.3 (2.8)	10.1 (3.2)	12.7 (2.5)	< 0.001
Base deficit (mEq/L)	4.8 (4.5)	5.2 (6.2)	4.5 (3.8)	0.280
INR	1.2 (0.7)	1.8 (1.2)	1.1 (0.5)	< 0.001
Health transport				0.413
Medicalized Ambulance	297 (56)	50 (56)	247 (58)	
Conventional ambulance	151 (30)	26 (29)	125 (29)	
Medicalized Helicopter	45 (9)	9 (10)	36 (9)	
Private vehicle	23 (5)	5 (5)	18 (4)	
Length of hospital stay [mean (SD)]	9.5 (9.5)	4.0 (5.0)	10.0 (7.0)	< 0.001
Serious anatomical and physiological indices				
Prehospital RTS [mean (SD)]	7.4 (3.4)	6.1 (1.6)	7.7 (3.6)	< 0.001
Prehospital T-RTS [mean (SD)]	11.5 (1.1)	10.0 (1.6)	11.7 (0.9)	< 0.001
Hospital RTS [mean (SD)]	7.2 (3.4)	5.4 (1.7)	7.3 (1.1)	< 0.001
Hospital T-RTS [mean (SD)] 1	11.1 (1.5)	9.2 (1.2)	11.5 (1.2)	< 0.001
ISS [mean (SD)]	19.5 (9.0)	26.5 (11.7)	18.3 (7.4)	< 0.001
NISS [mean (SD)]	26.7 (9.6)	35.6 (13.7)	25.2 (7.5)	< 0.001
Location of injuries (AIS > 2)				
Head	298 (58)	78 (87)	220 (52)	< 0.001
Face	11 (2)	2 (2))	9 (2)	0.613
Thoracics	254 (49)	34 (38)	220 (52)	0.004
Abdominal	58 (11)	8 (10)	50 (12)	0.295
Extremities and pelvic ring	49 (10)	6 (9)	43 (10)	0.322

*Other mechanisms refers to those not included in the previous ones among those that are crushed by machines or diverse objects. ASA-PS: pre-injury American Society of Anesthesiologists Physical Status Classification; INR: International Normalized Ratio; RTS: Revised Trauma Score; T-RTS: Triage-RTS; ISS: Injury Severity Score; NISS: New Injury Severity Score; AIS: Abbreviated Injury Scale.

that both models have a good predictive capacity and not statistically different, and given that it is easier to complete 4 variables than 13, it is possible that the MPMN could be more easily implanted in the care practice. In a study conducted in Finland by Raj et al. Different predictive models are validated and find, in a similar way to our study, good discrimination and worse precision and calibration. In addition, they recognize that the application of prediction models of mortality in PTG groups contributes to a better understanding of their reality and is necessary for the comparison and analysis of the quality of their assistance[23].

Our study has some limitations. In the first place, it is a retrospective design, and therefore it was not initially thought to calculate the RISC II, so in some cases it was not possible to apply all the independent predic-

Table 2. Coefficients of the RISC II variables with their corresponding description and values

Variables of the RISC II model	Coefficient	n (%)	Missing values n (%)
Constant	3.6		
Sex			0 (0)
Men	0	363 (70.0)	
Women	+0.2	153 (30.0)	
Intensity of the lesion[1]			
Worst injury			0 (0)
AIS 3	–0.5	192 (37.2)	
AIS 4	–1.3	233 (45.2)	
AIS 5	–1.7	89 (17.2)	
AIS 6	–2.9	2 (0.4)	
Second worst injury			0 (0)
AIS 0-2	+0.2	161 (31.2)	
AIS 3	0	304 (58.9)	
AIS 4	–0.6	45 (8.7)	
AIS 5-6	–1.4	6 (1.2)	
TBI[2]			0 (0)
AIS 0-2	0	218 (42.2)	
AIS 3-4	–0.2	219 (42.4)	
AIS 5-6	–0.8	79 (15.3)	
ASA-PS[3]			0 (0)
1-2	+0.3	342 (66.0)	
3	0	133 (26.0)	
4	–1.3	41 (8.0)	
Coagulation: INR			36 (7.0)
< 1.20	+0.6	383 (74.2)	
1.20-1.39	+0.2	23 (4.5)	
1.40-2.39, or missing valuess	0	42 (8.1)	
≥ 2.40	–0.4	32 (6.2)	
Acidosis: base deficit			332 (64.0)
< 6.0 mEq/L	+0.3	102 (20.0)	
6.0-8.9 mEq/L. or missing values	0	57 (11.0)	
9.0-14.9 mEq/L	–0.4	19 (3.8)	
≥ 15.0 mEq/L	–1.5	6 (1.2)	
Mechanism			0 (0)
Penetrating	–0.6	22 (4.0)	
Contusion	0	494 (96.0)	
Systolic blood pressure (mmHg)[4]			0 (0)
< 90 mmHg	–0.7	48 (9.0)	
90-110 mmHg	0	77 (15.0)	
111-150 mmHg	+0.3	307 (60.0)	
> 150 mmHg	0	84 (16.0)	
Pupillary reactivity[5]			41 (8.0)
Fixed	–1	16 (3.0)	
Slow or missing values	0	31 (6.0)	
Fast	+0.2	428 (83.0)	
Pupillary size[6]			41 (8.0)
Both dilated	–0.5	16 (3.0)	
Anisocoria or missing values	0	31 (6.0)	
Normal	+0.2	428 (83.0)	
Hemoglobin			2 (0.4)
< 7.0 mg/dL	–0.5	31 (6.0)	
7.0-11.9, or missing values	0	134 (26.0)	
≥ 12.0	+0.4	349 (67.6)	
Prehospital			
Cardiorespiratory arrest			0 (0)
Yes	–1.8	3 (0.6)	
No	0	513 (99.4)	

(Continue)

tive variables of the result. Some variables, such as the base deficit, were measured routinely, but often not documented. In addition, a prognostic model will always have better results in the population in which it was developed than in a different one[24-26]. In this sense, it should be taken into account that the RISC II is an in-

Table 2. Coefficients of the RISC II variables with their corresponding description and values (continuation)

Variables of the RISC II model	Coefficient	n (%)	Missing values n (%)
The motor component of the Glasgow coma scale			
de coma de Glasgow[7]			0 (0)
Normal (6)	+0.6	397 (76.9)	
Locate (4-5)	0	42 (8.1)	
Does not locate (2-3)	–0.4	6 (1.2)	
No response (1)	–0.8	71 (13.8)	
Age (years)			0 (0)
1-5	+1.4	8 (1.6)	
6-10	+0.6	4 (0.8)	
11-54	0	231 (44.8)	
55-59	–0.5	32 (6.2)	
60-64	–0.8	35 (6.8)	
65-69	–0.9	37 (7.2)	
70-74	–1.2	27 (5.2)	
75-79	–1.9	48 (9.3)	
80-84	–2.4	45 (8.2)	
≥ 85	–2.7	49 (9.5)	

AIS: Abbreviated Injury Scale; ASA-PS: pre-injury American Society of Anesthesiologists Physical Status Classification; INR: International Normalized Ratio; TBI: Traumatic Brain Injury. [1]Intensity of the injury according to the AIS scale. If there is only one injury coded, the value of the second worst injury will be 0. [2]Instance of the TBI according to the AIS scale. [3]Comfort according to the Utstein dictionary. [4]First value at patient's admission to the hospital in 4 categories. If no value is obtained, the prehospital value can also be used. [5]Pre-hospital data in 3 categories according to scale of Eppendorf-Cologne. If no value is obtained, it is also You can use the hospital value. [6]Pre-hospital data in 3 categories according to the scale of Eppendorf-Cologne. If you do not get any value, you can also use the hospital value. 7Use the scale of coma of Glasgow on admission in patients not intubated in 4 categories according to the scale of Eppendorf-Cologne. If the patient is missing or was intubated, using prehospital assessment.

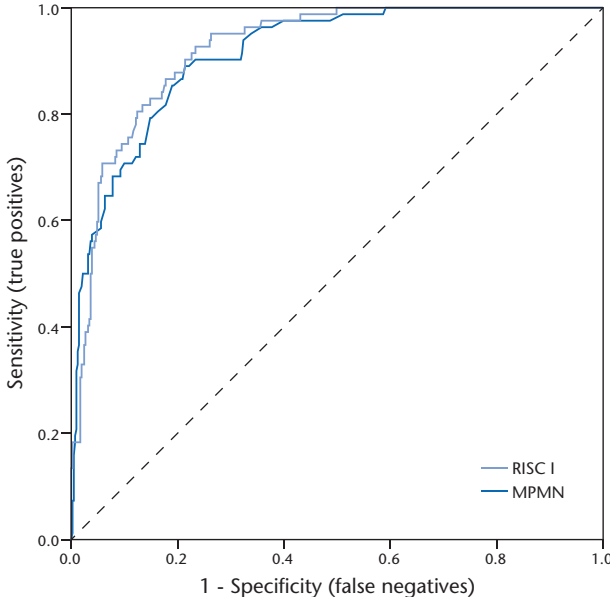

Figure 1. COR curves for MPMN and RISC II for the prediction of mortality at 30 days. The ABC of the MPMN COR was 0.927 (95% CI 0.902-0.952) and that of the RISC II was 0.941 (95% CI 0.921-0, 962) (p = 0.269). MPMN: Navarra Mortality Prediction Model; RISC II: Revised Injury Severity Classification II.

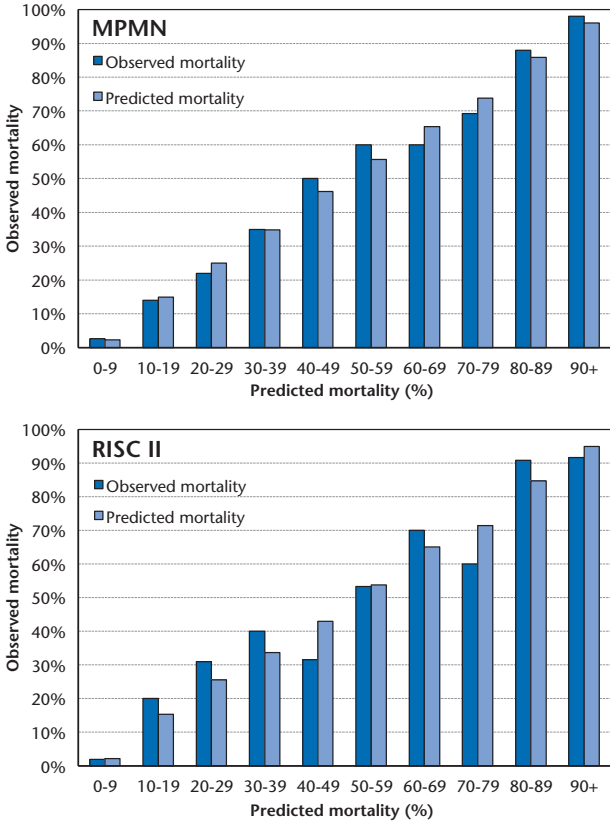

Figure 2. Concordance between predicted and observed mortality rates in 10 subgroups of patients with increased risk of death based on MPMN (above) and RISC II (below). The calibration of the model through the Hosmer-Lemesow test for MPMN was 13.6 (p = 0.09) and for RISC II of 8.9 (p = 0.35).

dex that comes from a population of traumatic patients treated mainly in Germany[14] and therefore the differences observed could also be due to the different systems of attention to multiple trauma in both countries. For this reason, differences in the system of attention to PST between both regions should be considered in future studies. Researchers continue to look for a better prediction model of mortality in the general traumatic patient population, paying close attention to the treatment of lost values, using the continuous variant of the predictor if available and incorporating all the available predictors, that is, physiological variables. anatomical variables, cause/mechanism of injury and demographic variables[3]. In this sense and as a conclusion, the MPMN and RISCII models show a good discrimination capacity to predict the 30-day global mortality among the analyzed PSTs and therefore they could be useful when stratifying the risk of dying of the PST. in Navarra. However, the MPMN is easier to collect due to the smaller number of variables necessary for its calculation

Conflicting interests

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

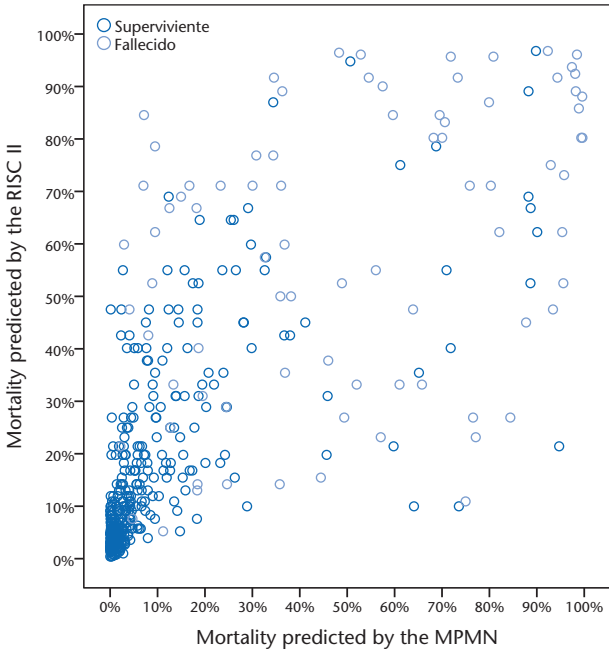

Figure 3. Predicted risk of death at 30 days for both models for survivors and deceased. The patients who died were identified and marked with different colors to differentiate them from the survivors, which allows to evaluate the concordance of both scores.

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Ethical Responsibilitiess

The study was approved by the Ethics Committee of the Health Department of Navarra (Pyto 2016/48). Informed consent was obtained from participants.

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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References

1 Shafi S, Nathens AB, Cryer HG, Hemmila MR, Pasquale MD, Clark DE, et al. The Trauma Quality Improvement Program of the American College of Surgeons Committee on Trauma. J Am Coll Surg. 2009;209:521-30.
2 Jones JM, Skaga NO, Sovik S, Lossius HM, Eken T. Norwegian survival prediction model in trauma: modelling effects of anatomic injury, acute physiology, age, and co-morbidity. Acta Anaesthesiol Scand. 2014;58:303-15.
3 De Munter L, Polinder S, Lansink KW, Cnossen MC, Steyerberg EW, de Jongh MA. Mortality prediction models in the general trauma population: A systematic review. Injury. 2017;48:221-9.
4 Champion HR, Copes WS, Sacco WJ, Lawnick MM, Keast SL, Bain LW, et al. The Major Trauma Outcome Study: establishing national norms for trauma care. J Trauma. 1990;30:1356-65.

5 Schluter PJ, Nathens A, Neal ML, Gobel S, Cameron CM, Davey TM, et al. Trauma and Injury Severity Score (TRISS) coefficients 2009 revision. J Trauma. 2010;68:761-70.
6 Cayten CG, Stahl WM, Murphy JG, Agarwal N, Byrne DW. Limitations of the TRISS method for interhospital comparisons: a multihospital study. J Trauma. 1991;31:471-81.
7 Demetriades D, Chan LS, Velmahos G, Berne TV, Cornwell III EE, Belzberg H et al. TRISS methodology in trauma: the need for alternatives. Br J Surg. 1998;85:379-84.
8 Demetriades D, Chan L, Velmanos GV, Sava J, Preston C, Gruzinski G, et al. TRISS methodology: an inappropriate tool for comparing outcomes between trauma centers. J Am Coll Surg. 2001;193:250-4.
9 Belzunegui T, Gradín C, Fortún M, Cabodevilla A, Barbachano A, Sanz JA. Major trauma registry of Navarre (Spain): the accuracy of different survival prediction models. Am J Emerg Med. 2013;31:1382-8.
10 Belzunegui T, Fortún M, Reyero D. Implantado en Navarra el primer registro de politraumatizados de base poblacional en España. Emergencias. 2013;25:196-200.
11 Ringdal KG, Coats TJ, Lefering R, Di Bartolomeo S, Steen PA, Røise O, et al. The Utstein template for uniform reporting of data following major trauma: A joint revision by SCANTEM, TARN, DGU-TR and RITG. Scand J Trauma Resusc Emerg Med. 2008;16:7.
12 Lefering R. Development and validation of the revised injury severity classification score for severely injured patients. Eur J Trauma Emerg Surg. 2009;5:437-47.
13 Gabbe BJ, Cameron PA, Wolfe R. TRISS: does it get better than this? Acad Emerg Med. 2004;11:181-6.
14 Lefering R, Huber-Wagner S, Nienaber U, Maegele M, Bouillon B. Update of the trauma risk adjustment model of the TraumaRegister DGUTM: the Revised Injury Severity Classification, version II. Crit Care. 2014;18:476.
15 Steyerberg EW, Moons KGM, van der Windt DA, Hayden JA, Perel P, Schroter S, et al. Prognosis Re- search Strategy (PROGRESS) 3: prognostic model research. PLoS Med. 2013;10:e1001381.
16 Altman DG, Royston P. What do we mean by validating a prognostic model? Stat Med. 2000;19:453-73.
17 Bouamra O, Wrotchford A, Hollis S, Vail A, Woodford M, Lecky F. Outcome prediction in trauma. Injury. 2006;37:1092-7.
18 Hoffmann M, Lehmann W, Rueger JM, Lefering R. Introduction of a novel trauma score. J Trauma Acute Care Surg. 2012;73:1607-13.
19 Lefering R, Paffrath T, Linker R, Bouillon B, Neugebauer EA. German Society for Trauma Surgery. Head injury and outcome— what influence do concomitant injuries have? J Trauma. 2008; 65:1036-43.
20 Lefering R, Paffrath T, Bouamra O, Coats TJ, Woodford M, Jenks T, et al. Epidemiology of in-hospital trauma deaths. Europ J Trauma Emerg Med. 2012;38:3-9.
21 Gabbe BJ, Cameron PA, Wolfe R, Simpson P, Smith KL, McNeil JJ: Prehospital prediction of intensive care unit stay and mortality in blunt trauma patients. J Trauma. 2005;59:458-65.
22 Huber-Wagner S, Stegmaier J, Mathonia P, Paffrath T, Euler E, Mutschler M, et al. The sequential trauma score - a new instrument for the sequential mortality prediction in major trauma. Eur J Med Res. 2010;15:185-95.
23 Raj R, Brinck T, Skrifvars MB, Handolin L. External validation of the Norwegian survival prediction model in trauma after major trauma in Southern Finland. Acta Anaesthesiol Scand. 2016;60:48-58.
24 Pape-Köhler CIA, Simanski C, Nienaber U, Lefering R. External factors and the incidence of severe trauma: time, date, season and moon. Injury. 2014;45(Supl 3):S93.
25 Moore L, Hanley JA, Turgeon AF, Lavoie A. Comparing regression-adjusted mortality to standardized mortality ratios for trauma center profiling. J Emerg Trauma Shock. 2012;5:333-7.
26 Sampalis JS, Lavoie A, Williams JI, Mulder DS, Kalina M. Standardized mortality ratio analysis on a sample of severely injured patients from a large Canadian city without regionalized trauma care. J Trauma. 1992;33:205-11.