BRIEF ORIGINAL

Mortality in patients with potentially severe trauma in a tertiary care hospital emergency department and evaluation of risk prediction with the GAP prognostic scale

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Objective. To assess mortality in patients with potentially severe injuries and explore the correlation between mortality and the score on the GAP scale (Glasgow Coma Scale, age, and systolic blood pressure).

Methods. Retrospective observational study of all patients with potentially severe injuries treated in an emergency department (ED) over a period of 15 months. We recorded epidemiologic variables, cause of injury, type of transport, need for prehospital orotracheal intubation, substance abuse, Charlson Comorbidity Index (CCI), variables for the GAP prognostic score, destination on discharge from the ED and at the end of the episode, and mortality.

Results. Data for 864 patients entered the final analysis. Mortality was higher in older patients (mean [SD] age, 57.9 [26.6] vs 41.1 [17.4], *P*<.05) and those with a higher mean CCI (3.3 [2.9] vs 0.9 [1.7]). Accident type was a precipitating factor associated with mortality (*P*<.001), but substance abuse was unrelated. Patients who died had lower mean Glasgow scores (9.1 [5.3] vs 14.8 [1.2], *P*<.001) and lower mean systolic and diastolic pressures (respectively, 113.8 [19.8] vs 131.3 [20.7] mm Hg, *P*=.012, and 60.1 [16.8] vs 77.7 [11.7] mm Hg, *P*=.002). Patients who died also had lower mean GAP scores than survivors (15.1 [4.8] vs 22.6 [1.7], *P*<.001). Risk factors that remained significant in the multivariate analysis were CCI (odds ratio [OR], 0.704; 95% CI, 0.52–0.96) and GAP score (OR, 1.8; 95% CI, 1.45–2.20).

Conclusions. Mortality in our patient series was lower than rates in previously published reports. The GAP score was a useful tool for predicting mortality in the series we studied.

Keywords: Trauma severity indices. Wounds. Injuries. Mortality. Emergency department.

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Mortalidad en el traumatismo potencialmente grave atendido en un servicio de urgencias de tercer nivel. Evaluación de la escala pronóstico de mortalidad gap

Objetivo. Describir la mortalidad de los pacientes atendidos con traumatismos potencialmente graves (TPG) y la correlación de dicha mortalidad con la escala GAP *(Glasgow coma scale, Age, and systolic bloob Pressure).*

Métodos. Estudio observacional retrospectivo con inclusión de todos los pacientes atendidos en urgencias durante 15 meses con TPG. Se registraron variables epidemiológicas, mecanismo lesional, tipo de traslado, necesidad de intubación orotraqueal extrahospitalaria, consumo de tóxicos, índice de comorbilidad de Charlson (ICC), variables incluidas en la escala de GAP, el destino tras la asistencia en urgencias y al final del episodio y la mortalidad.

Resultados. Se incluyeron 864 pacientes. La mortalidad fue mayor en pacientes mayores [57,9 (26,6) *vs* 41,1 (17,4), p < 0,05] y con mayor puntuación en el ICC [3,3 (2,9) *vs* 0,9 (1,7)]. La precipitación fue el tipo de accidente con mayor mortalidad (p < 0,001). No hubo asociación entre tóxicos y mortalidad. En los fallecidos tuvieron menor puntuación en la escala del coma de Glasgow [9,1 (5,3) *vs* 14,8 (1,2), p < 0,001], como la presión arterial sistólica [113,8 (19,8) *vs* 131,3 (20,7) mmHg, p = 0,012] y la diastólica [60,1 (16,8) *vs* 77,7 (11,7) mmHg, p = 0,002]. La puntuación en la escala GAP fue menor en los fallecidos frente a los supervivientes [5,1 (4,8) *vs* 22,6 (1,7), p < 0,001]. En el análisis multivariable se mantuvieron significativos el ICC (OR: 0,704; IC 95%: 0,52-0,96) y la escala GAP (OR: 1,8; IC 95%: 1,45-2,20).

Conclusiones. La mortalidad de nuestra serie de pacientes es baja en relación a lo publicado con anterioridad. El GAP es útil como escala pronóstica de mortalidad en nuestra cohorte de pacientes.

Palabras clave: Índice de gravedad del trauma. Heridas. Lesiones. Mortalidad. Urgencias.

Introduction

Potentially severe trauma requires urgent medical evaluation at a hospital equipped to treat patients with multiple trauma[1-3]. However, potential severity may sometimes go unnoticed due to factors such as prehospital sedation or endotracheal intubation (OTI) and / or the existence of internal injuries not identified at first examination. In this context, evaluation systems with prognostic scales have been developed, which are easy

to apply at first medical assistance[4]. In 1974, Teasdale et al.[5] at the University of Glasgow developed the Glasgow Coma Scale (GCS) for patients with traumatic brain injuries. Other scales have since been developed to assess non-traumatic brain injury and improve prognostic accuracy. The Trauma Score and, subsequently, the Revised Trauma Score, designed by Champion et al.[6,7], identified up to 97.2% of patients who would die or present very serious injuries, but it presented a high number of false negatives. The Injury Severity Scale (ISS) developed by Baker et al.[8], focuses on anatomic criteria and severity of injuries, but is limited by the need to have identified them at the time of initial assessment, before diagnostic test results. A simple prediction rule with high statistical significance is the MGAP, by Sartorius et al.[9], involving the following variables: Mechanism, GCS, Age and systolic blood Pressure (SBP). Kondo et al.[10] developed the GAP scale (GCS, age and SBP), eliminating the injury mechanism which they considered confusing since each injury mechanism had a fixed preset score of severity. The results were very similar to the previous scales, stratifying patients into three categories: mild (19-24 points), moderate (11 to 18) and severe (3 to 10).

The aim of this study was to describe the mortality rate of patients with potentially severe trauma attended in the emergency department (ED) of a tertiary hospital and to evaluate the correlation between GAP scale scores and mortality in these patients.

Method

A retrospective observational study including all adult patients treated at the critical patients area of our ED, Hospital Universitario La Paz de Madrid (HULPM) from 1 January 2012 to 31 March 2013. The following variables were recorded: age, gender, injury mechanism, type of transfer to the hospital, pre-hospital OTI, consumption of toxic substances, Charlson comorbidity index (CCI), variables included in the prognostic scale GAP[10], destination after first hospital attention and at the end of the episode, and mortality. The study was evaluated and approved by the HULPM Ethics Committee for Clinical Research. HULPM is a tertiary level 1,318-bed hospital serving a population of 503,010 inhabitants (year 2013). It is a reference center for the care of patients with multiple injuries in Madrid and, according to the American criteria for the care of trauma patients, is equivalent to a top level trauma center: it meets all the requirements established by the Committee on Trauma of the American College of Surgeons[3]. The ED has 65 beds, 30 structural chairs and a resuscitation area / critical care area with capacity for 4 patients, where the evaluation is performed of all potentially serious trauma (PST) patients by ED medical staff and other specialists when necessary.

The descriptive analysis was performed using the mean and standard deviation for continuous variables; and frequency and percentage for categorical variables.

Subsequently, a comparative analysis was conducted between patients who died and those who survived. We evaluated the correlation between mortality and GAP score and, additionally, the Revised Trauma Score (RTS). Univariate analysis was performed using Student's t and Mann-Whitney tests, as appropriate, for dichotomous variables versus numerical variables, and chi-square for categorical variables. Subsequently, a multivariate analysis was performed using multiple logistic regression, selecting those variables that were statistically significant in the univariate analysis with an alpha error of less than 0.1 and which met the criterion of plausibility. Statistical significance was considered to exist when alpha error was less than 5%. Data analysis was performed using SPSS v. 20.0 (Chicago, Illinois, USA).

Results

A total of 1,044 PST patients were attended in the ED. Of these, 180 (17.2%) were excluded due to missing data; the study therefore included 884 patients. Significant differences between survivors and non-survivors were observed in age, CCI, type of accident and transfer, and the need for OTI and prehospital sedation (Table 1). SBP, diastolic BP and mean BP, and GCS scores, differed between survivors and non-survivors (Table 2). A total of 53 patients had consumed central nervous system depressants: alcohol in 51 cases (96.2%), and opioids in 2 (3.8%). Cocaine was the only stimulant detected in 6 patients and the only hallucinogen was ketamine in one patient. Mean GAP score in survivors was 22.6 (1.7) versus 15.1 (4.8) in non-survivors ($p < 0.001$). Figure 1 shows the area under the curve (AUC) on receiver-operating characteristic (ROC) analysis for the GAP score (95% CI: 0.88 to 1, $p < 0.001$) to predict mortality.

A GAP score lower than 20 points predicted survival with a sensitivity of 94.9% and a specificity of 88.9% (Table 3). Using RTS scores, survivors had a mean 10.5 (0.22) versus 10.5 (0.71) in non-survivors ($p = 0.001$). Table 4 shows mortality in groups according to GAP scores, following the original stratification of Kondo et al.[10] as low, moderate or high risk, with estimated mortality of less than 5%, 5- 50% and above 50% respectively.

After initial assistance in the critical care area of the ED, patient destination was as follows: discharge after conventional observation room (less than 48 hours from admission) in 442 cases (51.2%); discharge after observation in short stay unit SSU (between 48 and 72 hours) in 229 cases (29.5%); hospitalization in 106 cases (12.1%); transfer to another hospital in 15 cases (1.3%) and unknown destination in 72 cases (8.8%). There was no difference in mean stay time between patients who survived and could be discharged and those who died during the critical episode [2.2 (8.8) vs 5.6 (5.8) days respectively ($P > 0.05$)]; in the case of non-survivors, mean stay was until the moment of death. The overall mean length of stay (survivors or non-survivors) was 2.3 (8.9) days.

For the multivariate survival analysis, we included all variables proving statistically significant on univariate

Table 1. Baseline characteristics of surviving and non-surviving patients with potentially severe trauma

	Survivors (N = 855) n (%)	Non-survivors (N = 9) n (%)	P
Age (years) [mean (SD)]	41.1 (17.4)	57.9 (26.6)	0.049
Female sex	382 (45.0)	4 (44.4)	0.6
Charlson Index [mean (SD)]	0.9 (1.7)	3.3 (2.9)	0.003
Type of accident			0.001
Road	775 (90.6)	5 (55.5)	
Fall	24 (2.8)	2 (22.2)	
Aggression	15 (1.7)	0	
Unknown	41 (4.78)	2 (22.2)	
Type of transfer			< 0.001
Own means	189 (22.1)	0	
Conventional ambulance	297 (33.6)	1 (11.1)	
Medicalized ambulance	86 (10.1)	7 (77.7)	
Unknown	282 (33.0)	1 (11.1)	
OTI * [n (%)]	24 (2.8)	4 (44.4)	< 0.001
Pre-hospital sedation	24 (2.8)	2 (22.2)	0.028
Alcohol	51 (6.0)	0	0.57
Drugs **	59 (6.9)	2 (22.2)	0.13
Depressants	53 (96.4)	2 (22.2)	0.1
Stimulants	6 (100)	0	1
Hallucinogenics	1 (100)	0	1

*OTI: orotracheal intubation by emergency medical service.
** Drug: considering all types of toxic substances together.

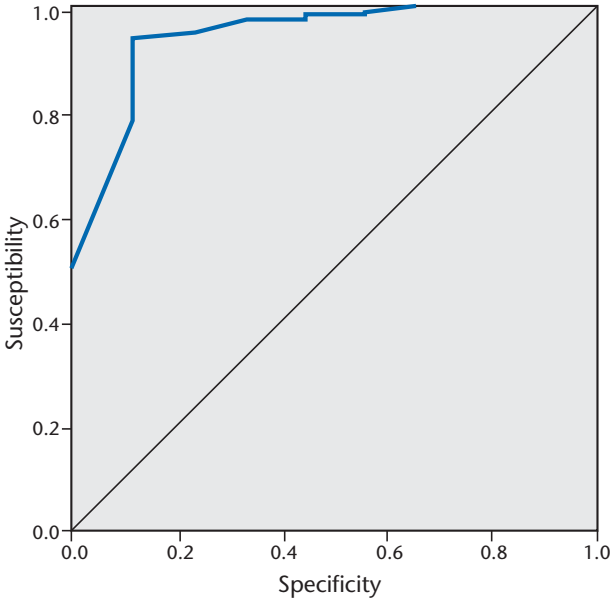

Figure 1. Area under the curve of survival according to GAP score (Glasgow coma scale, Age, and systolic blood Pressure).

analysis (Tables 1 and 2), except the type of transfer, prehospital sedation and OTI, considered confounders since they depended on trauma severity at the time of initial prehospital medical attention.

Of those analyzed, only the following remained significant: CCI (OR: 0.704, 95% CI: 0.517 to 0.959) and GAP score (OR: 1.78, 95% CI: 1.445 to 2.199).

Discussion

With this study we tried to answer two questions in the context of PST patients: firstly, we wished to determine the mortality rate of these patients in our institution and, secondly, to assess the accuracy of the GAP scale in this sample of patients. In our series, overall mortality was 1.04% (9 of 864 patients).

While there are studies that analyze mortality of PST patients, they are not comparable to our series, mainly due to heterogeneity of patient selection[1,2,11-13].

In our univariate analysis, mortality was related with age and CCI, type of accident (road), low SBP on ED arrival and GAP score. It seems logical that both low blood pressure and CCI should correlate with higher mortality and therefore that these factors which were statistically significant favored the GAP score. However, on multivariate analysis, it was the GAP score which correlated with mortality, as shown in Table 3 and in Figure 1, with 94.9 sensitivity and 88.9% specificity for scores below 20.5. The risk stratification in three groups from the original publication10 remained statistically correlated (low risk 0.4%, moderate risk: 18.7% high risk: 75%). Increased comorbidity (CCI) also remained a factor associated with increased mortality on multivariate analysis: patients with higher comorbidity have equal or poorer prognosis than those with increased injury severity. However, the persistent significance of GAP score on multivariate analysis allows us to establish that it is a useful scale, independent of patient comorbidity. Mortality was also significantly related to the type of trans-

Table 2. Vital signs and characteristics of the patients at the time of emergency department attention

	Survivors (855)	Non-survivors (9)	P
GAP score	14.8 (1.2)	9.1 (5.3)	< 0.001
Systolic blood pressure (mmHg)	131.3 (20.7)	113.8 (19.8)	0.012
Diastolic blood pressure (mmHg)	77.7 (11.7)	60.1 (16.8)	0.002
Mean arterial blood pressure (mmHg)	96.4 (12.9)	70.7 (14.0)	0.001
Respiration, (rpm)	16.5 (3.0)	23.0 (9.9)	0.27

GAP: Glasgow coma scale.

Table 3. Coordinates of the area under the survival curve and GAP score (Glasgow coma scale, Age, and systolic blood Pressure)

GAP score	Sensitivity (%)	Specificity (%)
9	100	0
11	99.9	33.3
12.5	99.5	44.4
13.5	99.4	44.4
14.5	99.3	44.4
15.5	99.2	55.6
16.5	98.7	55.6
17.5	98.5	55.6
18.5	98.4	66.7
19.5	95.8	77.8
20.5	94.9	88.9
21.5	79.2	88.9
22.5	51.3	100
23.5	49.8	100
25	0	100

Table 4. Mortality stratified by GAP score (Glasgow coma scale, Age, and systolic blood Pressure)

* GAP score	Preset mortality	Survivors N = 855 n (%)	Non-survivors N = 9 n (%)
19-24 points	< 5%	841 (99.6)	3 (0.4)
11-18 points	5-50%	13 (81.3)	3 (18.7)
3-10 points	> 50%	1 (25.0)	3 (75.0)

* GAP score according to the original reference Kondo et al.[10] p <0.001 calculated by chi-square.

fer and the need for during OTI during transfer, which are considered markers of initial severity and not variables with impact on mortality (patients transported by medicalized ambulance with or without OTI are in more severe condition and therefore present higher mortality). We were struck by the absence of statistical association between mortality and toxic substance consumption, although the small sample size of these patients may have influenced the result. In this regard, we would note that the protocol of care for the patients studied did not include a standardized study of toxic substances in urine or blood.

Our study has certain limitations. It was a single-center study, so our results need validation in other institutions to establish the utility of the GAP scale in other populations. The inclusion criteria, i.e. PST patients attended in the critical care area of our ED, could have biased the mortality data, since their admission was based on a subjective assessment of the care team receiving the patient. However, this allowed studying the entire spectrum of patients with PST, regardless of the preset variables (hypotension, anemia, etc.), one of the few studies to do so, along with the one published by Osler et al.[11], although their aim was different (analysis of differences in mortality in trauma patients before and after health care reform).

However, we conclude that the GAP scale appears to be a good prognostic indicator of mortality in our population. We propose to carry out a prospective multicenter study to confirm our results to facilitate the widespread use of this simple index.

Conflict of interest

The author declares no conflict of interest in relation to the present article.

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