

Mortality Prediction in Trauma Patients using Three Different Physiological Trauma Scoring Systems

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ABSTRACT

Background: This study aims to compare mortality prediction capabilities of three different physiological trauma scoring systems (TSS): Revised Trauma Score (RTS); Glasgow Coma Scale, Age, and Systolic Blood Pressure (GAP); and Mechanism, Glasgow Coma Scale, Age, and Arterial Pressure (MGAP).

Study design: A descriptive, cross-sectional study of trauma victims admitted to the emergency service between December-2013 and February-2014. Clinical and epidemiological information were gathered at admission and three TSS were calculated: RTS, GAP, and MGAP. The follow-up period to assess length of hospitalization and mortality lasted until August-2014. Two groups were created – survivals (S) and deaths (D) – and compared. $P < 0.05$ was considered statistically significant.

Results: A total of 668 trauma victims were analyzed. The mean age was 37 ± 18 and 69.8% were males. Blunt trauma prevailed (90.6%). The mean scores of RTS, GAP, and MGAP for group S ($n = 657$; 98.4%) were 7.77 ± 0.33 , 22.8 ± 1.7 , and 27.4 ± 2.3 respectively ($p < 0.001$), whereas group D ($n = 11$, 1.6%) achieved mean scores of 4.57 ± 2.95 , 13 ± 7 , and 15.5 ± 7 ($p < 0.001$). Regarding the Receiver Operating Characteristics (ROC) analysis, the areas under the curve were 0.926 (RTS), 0.941 (GAP), and 0.981 (MGAP). The three TSS demonstrated significant mortality prediction capabilities ($p < 0.001$). There

was no statistically significant difference between the three ROC curves ($p = 0.138$). The MGAP achieved the highest sensitivity (100%), while GAP and RTS sensitivities were 81.8% (59–100%), and 90.9% (73.9–100%) respectively ($p < 0.001$). The observed specificities were 96.2% (94.77–97.7%) for GAP, 91.6% (89.5–93.7%) for MGAP, and 87.2% (84.7–89.8%) for RTS ($p < 0.001$). Age ($p = 0.049$), Glasgow Coma Scale (GCS) ($p < 0.001$), and trauma mechanism ($p < 0.001$) were different between the two groups.

Conclusion: Most patients were young males and victims of blunt trauma. The three TSS demonstrated reliability regarding mortality prediction. The MGAP achieved the highest sensitivity and GAP was the most specific score, which may indicate a potential use of both as valuable alternatives to RTS.

Keywords: Cross-sectional studies, Emergency medical services, Glasgow coma scale, Hospitalization, Mortality, Receiver operating characteristics curve, Sensitivity and specificity, Trauma severity indices, Triage.

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RESUMO

Objetivo: Avaliar o poder preditivo de mortalidade de três scores de trauma (ST): Score de trauma revisado (RTS); escala de coma de Glasgow, idade e pressão arterial (GAP); e mecanismo, escala de coma de Glasgow, idade e pressão arterial (MGAP).

Materiais e Métodos: Estudo transversal e descritivo envolvendo vítimas de trauma admitidas no serviço de emergência entre Dezembro-2013 e Fevereiro-2014. Informações clínicas e epidemiológicas foram coletadas na admissão e três ST foram calculados: RTS, GAP e MGAP. Houve seguimento até Agosto-2014 para avaliar tempo de hospitalização e mortalidade. Dois grupos foram criados – sobreviventes (S) e óbitos (O) - e comparados. Significância estatística adotada: $p < 0,05$.

Resultados: Analisaram-se 668 vítimas de trauma. Registrou-se média de idade de 37 ± 18 anos, 69,8% sendo masculinos. Predominou o trauma contuso (90,6%). Para o grupo S ($n = 657$; 98,4%), as médias de RTS, GAP e MGAP foram, respectivamente, $7,77 \pm 0,33$, $22,8 \pm 1,7$ e $27,4 \pm 2,3$ ($p < 0,001$), enquanto o grupo O ($n = 11$, 1,6%) obteve médias de $4,57 \pm 2,95$, 13 ± 7 e $15,5 \pm 7$ ($p < 0,001$). A análise Receiver Operating Characteristics (ROC) revelou áreas abaixo da curva de 0,926 (RTS),

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0,941 (GAP) e 0,981 (MGAP) ($p < 0,001$). Todos os ST revelaram significativo poder preditivo de óbito ($p < 0,001$). As três curvas ROC não foram significativamente diferentes entre si ($p = 0,138$). MGAP atingiu a maior sensibilidade (100%), enquanto GAP e RTS obtiveram sensibilidades de 81,8% (59-100%) e 90,9% (73,9-100%). As especificidades foram de 96,2% (94,7-97,7%) para o GAP, 91,6% (89,5-93,7%) para o MGAP e 87,2% (84,7-89,8%) para o RTS. Idade ($p = 0,049$), escala de coma de Glasgow ($p < 0,001$) e mecanismo de trauma ($p < 0,001$) foram significativamente diferentes entre os dois grupos.

Conclusão: Observou-se predomínio de jovens masculinos, vítimas de trauma contuso. Os três ST demonstraram confiabilidade quanto à predição de óbito. MGAP atingiu a maior sensibilidade e GAP mostrou-se o mais específico, possivelmente indicando o uso de ambos como alternativas ao RTS.

Palavras-chave: Curva roc, Escala de coma de glasgow, Estudos transversais, Índices de gravidade do trauma, Hospitalização, Mortalidade, Sensibilidade e especificidade, Serviços médicos de emergência, Triagem.

INTRODUCTION

Trauma may be defined as a group of unpredictable and undesirable events, involving varied levels of violence, that result in injuries on its victims.¹ Such events represent one of the largest causes of morbidity and mortality in the world, nowadays being the leading cause of death in the population below 45 years of age, mostly male.² The World Health Organization had predicted 5.3 million deaths due to trauma for 2015 alone, representing 9.2% of the total for that period. In 2030, 6.3 million deaths from trauma are expected.³

Trauma also presents significant impact when analyzed from the economic standpoint. In the United States, it is estimated that in 2013 alone, trauma injuries caused losses of more than 670 billion dollars when combined medical costs and work disability costs secondary to trauma.⁴ In the same country, in 2014, trauma was responsible for over 2 million years of potential life lost.⁵ In Brazil, in 2012, about 1 million hospitalizations occurred as a result of trauma, US\$600.30 being the average cost of medical care for each victim. Approximately 150,000 deaths occur annually in Brazil due to trauma, most of them in the first hours after injury.^{6,7}

One of the most important challenges regarding trauma care is the fact that the victims' profiles differ significantly on nature and severity of injuries. This heterogeneity has been stimulating numerous scientific researches, especially with regard to the development of Trauma Scoring Systems (TSS), which involve the attribution of a certain score to trauma victims depending on specific variables.^{8,9} Trauma scoring systems may guide decisions involving both prehospital care—for example, if a specialized transport is required—and in-hospital care—such as, whether or not certain surgical procedures should be performed. In addition, TSS also provide important

information concerning the anatomy of the lesions, physiological changes, and prognosis. These scoring systems also optimize communication among health professionals by standardizing the language being used and contribute to the quality control of the trauma response services. Furthermore, TSS provide epidemiological data that may guide campaigns on trauma prevention.^{9,10}

Over the past years, a wide array of TSS were developed, including RTS, which considers three physiological parameters: Respiratory rate, systolic blood pressure and GCS.¹¹ Despite remaining widely used and discussed, the calculation of RTS involves overly complex formulas, which could delay trauma care to the patient. This was one of the most important factors that inspired the development of two other TSS: GCS, age, and arterial pressure (GAP); and mechanism, GCS, age, and arterial pressure (MGAP).^{12,13} The calculations of GAP and MGAP may be easily performed either at the trauma scene or in the hospital setting.⁹ In addition, both GAP and MGAP have the ability to predict mortality almost as precisely as the Trauma-Related-Injury Severity Score (TRISS), one of the most reliable TSS regarding prognosis.¹²⁻¹⁶

In this context, the objective of the present study is to compare the mortality prediction capabilities of three physiological TSS: RTS, GAP, and MGAP.

MATERIALS AND METHODS

A descriptive, cross-sectional study was conducted involving trauma victims admitted to the emergency room of a Brazilian specialized trauma care center between December-2013 and February-2014. Data were uninterruptedly gathered by Medical students from a trauma academic league – Liga Acadêmica do Trauma do Hospital Universitário Cajuru (LATHUC). The students had previously received training on how to properly gather the data.

Three physiological TSS (RTS, GAP, and MGAP) were calculated at admission (Table 1). In order to perform these calculations, the following variables were analyzed: respiratory rate, GCS, systolic blood pressure, trauma mechanism, and age. Gender and trauma occurrence throughout the week were also analyzed at admission. Mortality and length of hospitalization were assessed during a follow-up period that lasted until August-2014.

Two groups were created – deaths (D) and survivals (S) – and compared in relation to the TSS, gender, age, GCS, and trauma mechanism. Student's t-test and the nonparametric Mann-Whitney test were used to analyze quantitative variables, such as, means and standard deviations. Chi-square test was used for qualitative variables, like frequencies and percentages. In order to compare the predictive power of the three TSS—RTS, GAP, MGAP—an analysis of the ROC curve was performed, including

Table 1: Variables involved in the calculation of GAP and MGAP^{12,13}

Variables	GAP	MGAP
Glasgow Coma Scale	+3–15	+3–15
Age		
<60	+3	+5
≥60	0	0
Systolic blood pressure (mmHg)		
>120	+6	+5
60–120	+4	+3
<60	0	0
Mechanism of trauma (MGAP only)		
Blunt	–	+4
Penetrating	–	0

GAP: Glasgow Coma Scale, Age, and Arterial Pressure; MGAP: Mechanism, Glasgow Coma Scale, Age, and Arterial Pressure

cut-off values, sensibilities, and specificities. The adopted level of significance in this study is 5% ($p < 0.05$). STATA software (v. 13.1) was used to analyze the collected data. This study was approved by the Research Ethics Committee of the Pontifical Catholic University of Paraná, Brazil (decision 480.483 of April 12th 2013).

RESULTS

The data of 668 patients were collected between December 2013 and February 2014. The mean age was 37 ± 18 years and most patients (69.8%) were male. Trauma occurrences were most frequent on Saturday (20.1%), Monday (17.5%), and Sunday (14.8%). Additional epidemiology data is available in Table 2. Blunt trauma accounted for 90.6% of the cases, while penetrating trauma corresponded to 9.4%. The most frequently observed trauma mechanisms were motorcycle accident (30.1%), same-level fall (16.9%) and automobile accident (12.9%). Frequencies of other trauma mechanisms are available in Graph 1. As for the length of stay, 65.6% of the patients analyzed, remained in the hospital for less than 24 hours; 18.1% required hospitalization between 1 to 2 days; 9.6% between 3 to 7 days; and 6.7% were hospitalized for 8 days or longer.

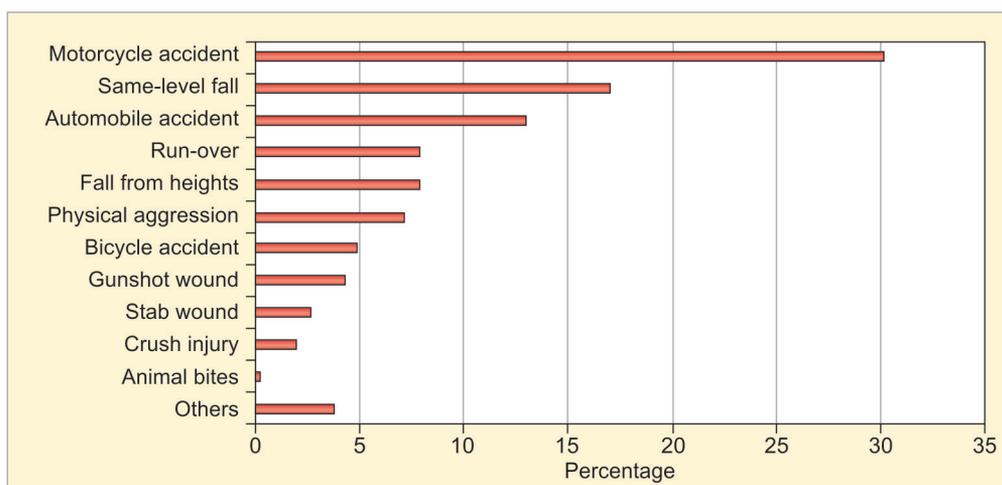
Table 2: Clinic-epidemiological data of admitted trauma victims

	n	%	Mean ± standard deviation
Age (years)			37 ± 18
Glasgow Coma Scale			$15 (3–15)^*$
Revised Trauma Score			7.71 ± 0.63
<i>Gender</i>			
Male	466	69.8	
Female	202	30.2	
<i>Type of injury</i>			
Blunt	605	90.6	
Penetrating	63	9.4	
<i>Day of the week</i>			
Sunday	99	14.8	
Monday	117	17.5	
Tuesday	71	10.6	
Wednesday	97	14.5	
Thursday	76	11.4	
Friday	74	11.1	
Saturday	134	20.1	
<i>Length of hospitalization</i>			
<1 day	438	65.6	
1 to 2 days	121	18.1	
3 to 7 days	64	9.6	
>1 week	45	6.7	

*Median (minimum-maximum)

Patients who survived (group S) amounted to 657 (98.4%) and 11 patients (1.6%) had death (group D) as an outcome. Group S had a mean age of 36.7 ± 17.8 years, whereas the mean age for group D was 55.2 ± 27.4 years ($p = 0.049$). The GCS scores presented asymmetrically, with 86.5% of the victims scoring 15 points. The GCS median, minimum, and maximum values were 15 (3–15) for Group S and 3 (3–15) to groups D (Table 3).

The mean scores of GAP, MGAP, and RTS for group S were 22.8 ± 1.7 , 27.4 ± 2.3 , and 7.77 ± 0.33 , whereas these scores for group D were 13 ± 7 , 15.5 ± 7 , and 4.57 ± 2.95 respectively ($p < 0.001$) (Table 4). There were significant



Graph 1: Distribution of trauma mechanisms (%)

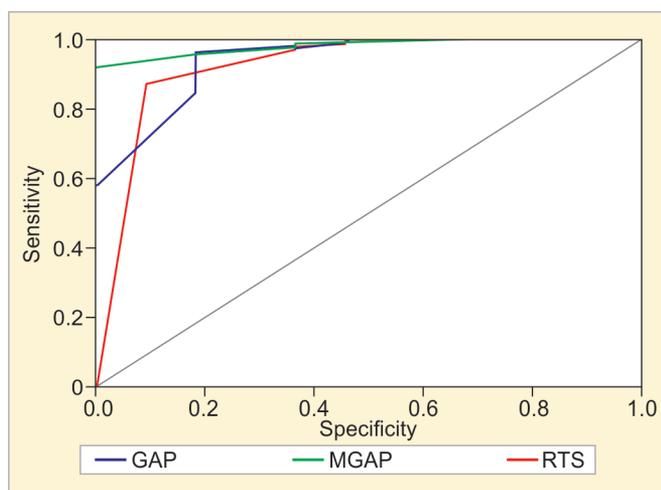
Table 3: Comparison of age, gender, Glasgow Coma Scale and trauma mechanisms between survivals (group S) and deaths (group D)

Variables		Group S (n = 657)	Group D (n = 11)	p-value
Age (years)		36.7 ± 17.8*	55.2 ± 27.4*	0.049
Gender	Female	200 (30.4%)	2 (18.2%)	0.340
	Male	457 (69.6%)	9 (81.8%)	
Mechanism	Blunt	600 (91.3%)	5 (45.4%)	<0.001
	Penetrating	57 (8.7%)	6 (54.6%)	
GCS		15 (3–15)**	3 (3–15)**	<0.001

*Mean ± standard deviation; **Median (minimum–maximum)

Table 4: Comparison between survivals (groups S) and deaths (group D) regarding RTS, GAP and MGAP

Score	Group	Mean	Standard deviation	p-value
RTS	S	7.77	0.33	<0.001
	D	4.57	2.95	
GAP	S	22.8	1.7	<0.001
	D	13	7	
MGAP	S	27.4	2.3	<0.001
	D	15.5	7	

**Graph 2:** Analysis of the Receiver Operating Characteristic (ROC) curve. RTS: Revised Trauma Score; GAP: Glasgow Coma Scale, Age, and Arterial Pressure; MGAP: Mechanism, Glasgow Coma Scale, Age, and Arterial Pressure

statistical differences between the three scores in relation to both groups ($p < 0.001$).

The ROC curve (Graph 2) was analyzed so as to evaluate predictive power for death of the three TSS calculated at admission. The cut-off points indicated by the ROC curve adjustment were 7.7 for RTS, 19 for GAP, and 23 for MGAP (Table 5). The areas under the curve (AUC) were 0.926 for RTS ($p < 0.001$), 0.941 for GAP ($p < 0.001$), and 0.981 for MGAP ($p < 0.001$). Comparison of the three ROC curves revealed no statistically significant difference regarding the efficacy to predict deaths of the three TSS ($p = 0.138$).

Sensitivity and specificity were obtained considering a confidence interval of 95%. Regarding sensitivity, RTS achieved 90.9% (73.9–100%), whereas GAP and MGAP obtained 81.8% (59–100%) and 100% respectively. As of specificity, the performances were: 87.2% (84.7–89.8%) for

RTS, 96.2% (94.7–97.7%) for GAP, and 91.6% (89.5–93.7%) for MGAP.

DISCUSSION

In this study, the majority of occurrences involved male subjects of working age¹⁷ and victims of blunt trauma. Most traumas were due to traffic accidents, i.e., motorcycle, automobile, and bicycle accidents; and run-overs. These epidemiologic findings corroborate the data found in the literature.^{2,4,7,8,18}

According to Trunkey,¹⁹ mortality due to trauma follows a trimodal distribution: Group I (50%) represents the often fatal injuries, usually resulting in death at the trauma scene; group II (30%) occurs within minutes to hours after the traumatic event and involves serious injuries that are potentially fatal in the absence of intensive primary care; and group III (20%) occurs from days to weeks after the event due to complications, such as, multiple organ failure and/or sepsis. Mortality related to groups II and III can be minimized by rapid and effective treatments. Therefore, a reliable and easily calculated TSS may help prevent mortality.^{9,20}

Currently, TRISS has been held as one of the most reliable TSS regarding prognosis, being widely discussed in the literature.^{9,12,15} However, since it is an anatomical trauma score, meticulous examination of the lesions and even imaging exams, which are not always immediately available, must be performed. This could delay the initial assessment of trauma victims and their proper care, representing an important limitation to the use of anatomical scores.⁹ Thus, an alternative would be the use of TSS that consider physiological parameters, which may promptly indicate the existence of serious injuries and stratify death risk. In addition to using physiological variables that are

Table 5: Comparison of cut-off values, sensibility, specificity, and AUC for RTS, GAP and MGAP

Score	Cut-off value	Sensitivity* (%)	Specificity* (%)	AUC	p-value
RTS	7.7	90.9 (73.9–100)	87.2 (84.7–89.8)	0.926	<0.001
GAP	19	81.8 (59–100)	96.2 (94.7–97.7)	0.941	<0.001
MGAP	23	100	91.6 (89.5–93.7)	0.981	<0.001

*Confidence Interval: 95%.

quickly obtained, it is important that the calculations of TSS be easily performed.²¹ Regarding this aspect, GAP and MGAP stand out because they require simpler calculations, which could expedite the evaluation of trauma victims and improve the quality of both pre-hospital and hospital care.¹²

In this study, all three indexes—RTS, GAP and MGAP—demonstrated significant capability in predicting mortality in patients admitted to the emergency room, since the means of each TSS for the two groups – survivals and deaths – were significantly different ($p < 0.001$). This important prediction capability is also demonstrated visually through the extensive AUC of each ROC analysis. In this study, values below 7.7 (RTS), 19 (GAP), and 23 (MGAP) indicated a higher chance of death as an outcome.

When compared with each other regarding their respective ROC curves, the TSS demonstrated no statistically significant differences in mortality prediction. This finding differs from other published studies that demonstrate significant differences between these indexes, in which GAP and MGAP were better predictors of mortality when compared to RTS.^{9,12,13} Moreover, according to Kondo et al,¹³ GAP is a better predictor of mortality than MGAP.

As for sensitivity, MGAP stood out in relation to RTS and GAP, the latter achieving the poorest performance in this aspect. Therefore, MGAP was associated with fewer false negatives for mortality, implying that a score above 23 drastically reduces the probability of death. Regarding specificity, GAP was superior compared to MGAP and RTS, the latter being the least specific of them all. Hence, GAP was associated with fewer false positives for mortality, meaning that a GAP value below 19 strongly suggests death as an outcome.

It has been demonstrated higher morbidity and mortality in elderly trauma patients when compared to younger patients victims of similar traumas.^{22,23} Some studies even indicate an increase in mortality from the 4th decade of life onwards.^{12,24,25} In this study, the mean age of patients who did not survive was significantly different than patients who survived (55.2 and 36.7 years respectively). This observation reinforces the importance of taking age into consideration and could partially explain the performance differences between GAP and MGAP, which are modified according to age; and RTS, which remains the same regardless of age. Another possible explanation for RTS's slightly worse performance in this study is the fact that, unlike MGAP, it does not take into consideration the trauma mechanism, even though penetrating traumas are more frequently associated with death—as already demonstrated in the literature.¹²

CONCLUSION

In the present study, most patients were young males and victims of blunt trauma. Lower RTS, GAP, and MGAP at admission involved higher mortality rates. Despite sample limitations, such as few deaths, the performances of both GAP and MGAP indicate their potential use as alternatives to RTS – especially considering that, when compared to the latter, GAP achieved a higher specificity, whereas MGAP demonstrated superiority in terms of sensitivity and specificity.

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REFERENCES

1. Sociedade Brasileira de Atendimento Integrado ao Trauma. O que é trauma? [Internet]. [cited 2017 Feb 2]. Available from: <http://www.sbait.org.br/trauma.php>
2. von Bahten LC, Alcantara EM, Pimenta APP, Dallagnol JC, Yoshizumi KO, Dresch MF. O impacto econômico do trauma em um hospital universitário. *Rev Col Bras Cir*. 2003;30(3):224-229.
3. World Health Organization. Global status report on violence prevention 2014 [Internet]. Geneva, Switzerland: World Health Organization; 2014 Available from: http://www.who.int/violence_injury_prevention/violence/status_report/2014/en/
4. Florence C, Simon T, Haegerich T, Luo F, Zhou C. Estimated lifetime medical and workloss costs of fatal injuries—United States, 2013. *Morbidity and Mortality Weekly Report (MMWR)* 2015 Oct 2;64(38): 1074-1077.
5. Centers for Disease Control and Prevention. Web-based Injury Statistics Query and Reporting System. Years of Potential Life Lost (YPLL) Reports, 1999R2014 [Internet]. [cited 2017 Feb 2]. Available from: <http://webappa.cdc.gov/sasweb/ncipc/ypll10.htm>
6. Carreiro PRL, Drumond DAF, Starling SV, Moritz M, Ladeira RM. Implementation of a trauma registry in a Brazilian public hospital: the first 1,000 patients. *Rev Col Bras Cir* 2014;41(4):251-255.
7. Solagberu BA, Adekanye AO, Ofoegbu CPK, Udoffa US, Abdur-Rahman LO, Taiwo JO. Epidemiology of trauma deaths. *West Afr J Med* 2003;22(2):177-181.
8. Fraga GP, Mantovani M, Magna LA. Índices de trauma em pacientes submetidos à laparotomia. *Rev Col Bras Cir* 2004;31(5):399-306.
9. Ahun E, Köksal Ö, Siğirli D, Torun G, Dönmez SS, Armağan E. Value of the Glasgow coma scale, age, and arterial blood pressure score for predicting the mortality of major trauma patients presenting to the emergency department. *Ulus Travma Acil Cerrahi Derg* 2014 Jul;20(4):241-247.
10. Hasler RM, Mealing N, Rothen HU, Coslovsky M, Lecky F, Jüni P. Validation and reclassification of MGAP and GAP in hospital settings using data from the Trauma Audit and Research Network. *J Trauma Acute Care Surg* 2014 Nov;77(5): 757-763.

11. Champion HR, Sacco WJ, Copes WS, Gann DS, Gennarelli TA, Flanagan ME. A revision of the trauma score. *J Trauma* 1989 May;29(5):623-629.
12. Sartorius D, Le Manach Y, David JS, Rancurel E, Smail N, Thicoipé M, Wiel E, Ricard-Hibon A, Berthier F, Gueugniaud PY, et al. Mechanism, glasgow coma scale, age, and arterial pressure (MGAP): a new simple prehospital triage score to predict mortality in trauma patients. *Crit Care Med* 2010 Mar;38(3):831-837.
13. Kondo Y, Abe T, Kohshi K, Tokuda Y, Cook EF, Kukita I. Revised trauma scoring system to predict in-hospital mortality in the emergency department: Glasgow coma scale, age, and systolic blood pressure score. *Crit Care* 2011 Aug;15(4):1-8.
14. Boyd CR, Tolson MA, Copes WS. Evaluating trauma care: the TRISS method. Trauma score and the injury severity score. *J Trauma* 1987 Apr;27(4):370-378.
15. Llullaku SS, Hyseni NS, Bytyçi CI, Rexhepi SK. Evaluation of trauma care using TRISS method: the role of adjusted misclassification rate and adjusted w-statistic. *World J Emerg Surg* 2009 Jan;4:2.
16. Rahmani F, Bakhtavar HE, Vahdati SS, Hosseini M, Esfanjani RM. Evaluation of MGAP and GAP Trauma Scores to Predict Prognosis of Multiple-trauma Patients. *Trauma Mon* 2017;22(3):1-6.
17. Instituto Brasileiro de Geografia e Pesquisa. Indicadores sociais mínimos [Internet]. [cited 2017 Feb 2]. Available from: <http://www.ibge.gov.br/home/estatistica/populacao/condicaoodevida/indicadoresminimos/conceitos.shtm>
18. Oliveira GN, Silva MFN, Araújo IEM, Carvalho Filho MA. Perfil da população atendida em uma unidade de emergência referenciada. *Rev Latino-Am Enfermagem* 2011;19(3):1-9.
19. Campbell NRC, Chen G. Canadian efforts to prevent and control hypertension. *Can J Cardiol* 2010 Aug-Sep;26(Suppl C):14C-7C.
20. Gunst M, Ghaemmaghami V, Gruszecki A, Urban J, Frankel H, Shafi S. Changing epidemiology of trauma deaths leads to a bimodal distribution. *Proc (Bayl Univ Med Cent)* 2010 Oct;23(4):349-354.
21. Joosse P, Soedarmo S, Luitse JS, Ponsen KJ. Trauma outcome analysis of a Jakarta University Hospital using the TRISS method: validation and limitation in comparison with the major trauma outcome study. *Trauma and injury severity score. J Trauma*. 2001 July;51(1):134-140.
22. Hranjec T, Sawyer RG, Young JS, Swenson BR CJ. Mortality factors in geriatric blunt trauma patients: creation of a highly predictive statistical model for mortality using 50,765 consecutive elderly trauma admissions from the National Sample Project. *Am Surg* 2012;78(12):1369-1375.
23. Jacobs DG, Plaisier BR, Barie PS, Hammond JS, Holevar MR, Sinclair KE, Scalea TM, Wahl W, EAST Practice Management Guidelines Work Group. Practice management guidelines for geriatric trauma: the EAST Practice Management Guidelines Work Group. *J Trauma* 2003 Feb;54(2):391-416.
24. Morris Jr J, MacKenzie E, Edelstein S. The effect of preexisting conditions on mortality in trauma patients. *JAMA [Internet]*. 1990 Apr 11;263(14):1942-1946.
25. Harnod D, Chen RJ, Chang WH, Chang CH. Mortality factors in major trauma patients: Nation-wide population-based research in Taiwan. *Int J Gerontol [Internet]*. 2014;8(1):18-21.

INVITED COMMENTARY

Trauma is a major cause of morbidity and mortality; hence, severity scales are important adjuncts to trauma care in order to characterize the nature and extent of injury. Trauma scoring models can assist with triage and help in evaluation and prediction of prognosis in order to organize and improve trauma systems.¹ Trauma mortality rates depend on injury severity, time to assessment, and time to reach an appropriate care center. Prompt assessment and appropriate triage can decrease rates of mortality and long-term disability. Validated trauma scoring systems can aid at obtaining these objectives, so there is a critical need to have a rapid, accurate, and practical prognostic scoring system that is easy to use by anyone involved in patient care. Several such systems have been developed. These differ in their complexity, design, and accuracy and previous studies have compared the accuracy of the commonly used scoring systems in predicting mortality. The Revised Trauma Score (RTS); the Glasgow coma scale, age, and systolic blood pressure (GAP) score; and the mechanism of injury, Glasgow coma scale, age, and systolic blood pressure (MGAP) score are all current tools utilized for this purpose and incorporate functional parameters in their calculations. The RTS was designed as a physiological scoring system to be used for prehospital trauma triage and it includes the variables respiratory rate, systolic blood pressure, and the Glasgow coma scale, which are weighted differently and summed up to a maximum score of 12.² The actual formula for RTS is

$$\text{RTS} = (0.9368 \text{ of GCS value}) + (0.7326 \text{ of SBP value}) + (0.2908 \text{ of RR value})$$

I agree with the authors that despite remaining widely used and discussed, the calculation of RTS involves an overly complex formula, which could delay patient care. As a consequence, the GAP and MGAP scores were developed as simple prehospital scoring systems. Unlike the others, MGAP incorporates mechanism of injury (blunt or penetrating) into its model. Since its development in 2010, it has been tested and validated. The MGAP trauma score was found to be superior to RTS in predicting intrahospital mortality in a cohort of trauma patients in the Northern French Alps.³ Also, the Spaniard authors Llompart-Pou et al⁴ have previously performed a similar comparative analysis, as the current authors, and found that MGAP and GAP scores performed better than the RTS in the prediction of hospital mortality in their trauma intensive care unit patients.

In most low- and middle-income countries, the resources to accurately quantify injury severity using traditional complex injury scoring systems are limited. The GAP and MGAP are more feasible to calculate in low-resource settings.⁵ The authors achieved their objective of comparing the mortality predictive powers of RTS, GAP, and MGAP scores in major trauma patients admitted to their emergency room. They found that all calculated trauma scoring systems revealed a significant mortality prediction power. Even though trauma scores are not the key elements of trauma treatment, they are however an essential part of improvement in triage decisions and in identifying patients with unexpected outcomes.¹ Prehospital triage of trauma patients is of paramount importance because adequate trauma center referral improves survival by accurately classifying trauma patients, assisting in clinical decision making, and predicting mortality.

REFERENCES

1. Rapsang AG, Shyam DC. Scoring systems of severity in patients with multiple trauma. *Cir Esp* 2015 Apr;93(4):213-221.
2. Miller RT, Nazir N, McDonald T, Cannon CM. The modified rapid emergency medicine score: a novel trauma triage tool to predict in-hospital mortality. *Injury* 2017 Sep;48(9):1870-1877.
3. Bouzat P, Legrand R, Gillois P, Ageron FX, Brun J, Savary D, Champly F, Albaladejo P, Payen JF, TRENAU Group. Prediction of intra-hospital mortality after severe trauma: which pre-hospital score is the most accurate? *Injury* 2016 Jan;47(1):14-18.
4. Llompart-Pou JA, Chico-Fernández M, Sánchez-Casado M, Salaberria-Udabe R, Carbayo-Górriz C, Guerrero-López F, González-Robledo J, Ballesteros-Sanz MA, Herrán-Monge R, Serviá-Goixart L, et al. Scoring severity in trauma: comparison of prehospital scoring systems in trauma ICU patients. *Eur J Trauma Emerg Surg* 2017 Jun;43(3):351-357.
5. Laytin AD, Dicker RA, Gerdin M, Roy N, Sarang B, Kumar V, Juillard C. Comparing traditional and novel injury scoring systems in US level I trauma center: an opportunity for improved injury surveillance in low-and middle-income countries. *J Surg Res* 2017 Jul;215:60-66.

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 INVITADO COMENTARIO

Mortality Prediction among Trauma Patients using Three Different Trauma Scoring Systems: Revised Trauma Score; Glasgow Coma Scale, Age, and Arterial Pressure Score; and Trauma Mechanism, Glasgow Coma Scale, Age, and Arterial Pressure Score

El trauma es una gran causa de morbilidad y mortalidad; razón por la cual las escalas de gravedad son complementos importantes para la atención del trauma, con el fin de caracterizar la naturaleza y el alcance de la lesión. Los modelos de puntuación de trauma pueden ayudar con el triaje y ayudar en la evaluación y predicción del pronóstico para organizar y mejorar los sistemas de trauma.¹ Las tasas de mortalidad por trauma dependen de la gravedad de la lesión, el tiempo de evaluación y el tiempo para llegar a un centro de atención apropiado. La evaluación oportuna y la clasificación adecuada pueden disminuir las tasas de mortalidad y la discapacidad a largo plazo. Los sistemas validados de puntuación de trauma pueden ayudar a obtener estos objetivos, por lo que existe una necesidad crítica de contar con un sistema de puntuación pronóstica rápido, preciso y práctico que sea fácil de usar por cualquier persona involucrada en la atención del paciente. Varios de estos sistemas han sido desarrollados. Estos difieren en su complejidad, diseño y precisión, y estudios previos han comparado la precisión de los sistemas de puntuación comúnmente utilizados para predecir la mortalidad. El puntaje de trauma revisado (RTS – por sus siglas en inglés); la escala de coma de Glasgow, la edad y la puntuación de la presión arterial sistólica (BPA – por sus siglas in inglés); y el mecanismo de lesión, escala de coma de Glasgow, edad y presión arterial sistólica (MGAP – por sus siglas en inglés) son herramientas actuales utilizadas para este propósito e incorporan parámetros funcionales en sus cálculos. El RTS se diseñó como un sistema de puntaje fisiológico para el triaje de trauma pre hospitalario e incluye las variables frecuencia respiratoria, presión arterial sistólica y escala de coma de Glasgow, que se ponderan de forma diferente y se suman a un puntaje máximo de 12.² La fórmula actual para RTS es:

$$\text{RTS} = (0.9368 \text{ del valor de la escala de coma de Glasgow}) + (0.7326 \text{ del valor de la presión arterial sistólica}) + (0.2908 \text{ del valor de la frecuencia respiratoria})$$

Estoy de acuerdo con los autores en que, a pesar de permanecer ampliamente utilizado y discutido, el cálculo de RTS implica una fórmula demasiado compleja que podría retrasar la atención del paciente. Como consecuencia, los puntajes de GAP y MGAP se desarrollaron como simples sistemas de puntuación pre hospitalarios. A diferencia de los otros, MGAP incorpora un mecanismo de lesión (contundente o penetrante) en su modelo. Desde su desarrollo en 2010, ha sido probado y validado. Se descubrió que el puntaje de trauma MGAP es superior al RTS para predecir la mortalidad intrahospitalaria en una cohorte de pacientes con traumatismos en los Alpes franceses del norte.³ Además, los autores españoles Llompert-Pou et al han realizado previamente un análisis comparativo similar, como los autores actuales, y encontraron que los puntajes MGAP y GAP se desempeñaron mejor que el RTS en la predicción de la mortalidad hospitalaria en pacientes con trauma en la UCI.⁴

En la mayoría de los países de ingresos bajos y medianos, los recursos para cuantificar con precisión la gravedad de las lesiones utilizando los sistemas de puntuación de lesiones complejas tradicionales son limitados. GAP y MGAP son más factibles de calcular en entornos de bajos recursos.⁵ Los autores lograron su objetivo de comparar los poderes predictivos de la mortalidad de las puntuaciones RTS, GAP y MGAP en los pacientes con traumatismos mayores ingresados en su sala de urgencia. Encontraron que todos los sistemas calculados de puntuación de trauma revelaron un poder de predicción de mortalidad significativo. A pesar de que las puntuaciones de trauma no son los elementos clave del tratamiento de trauma, son una parte esencial de la mejora en las decisiones de triaje y en la identificación de pacientes con resultados inesperados.¹ El triaje pre hospitalario de los pacientes con traumatismo es de suma importancia porque una referencia adecuada del centro de traumatología mejora la supervivencia clasificando con precisión a los pacientes con traumatismos, ayudando en la toma de decisiones clínicas y prediciendo la mortalidad.

REFERENCIAS

1. Rapsang AG, Shyam DC. Scoring systems of severity in patients with multiple trauma. *Cir Esp* 2015 Apr;93(4):213-221.
2. Miller RT, Nazir N, McDonald T, Cannon CM. The modified rapid emergency medicine score: A novel trauma triage tool to predict in-hospital mortality. *Injury* 48(2017):1870-1877.
3. Bouzat P, Legrand R, Gillois P, Ageron FX, Brun J, Savary D, Champly F, Albaladejo P, Payen JF; TRENAU Group. Prediction of intra-hospital mortality after severe trauma: which pre-hospital score is the most accurate? *Injury* 2016 Jan;47(1):14-18.

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4. Llompart-Pou JA, Chico-Fernandez M, Sanchez-Casado M, Salaberria-Udabe R, Carbayo-Górriz C, Guerrero-López F, González-Robledo J, Ballesteros-Sanz MÁ, Herrán-Monge R, Servià-Goixart L, et al. Scoring severity in trauma: comparison of prehospital scoring systems in trauma ICU patients. *Eur J Trauma Emerg Surg* 2017 Jun;43(3):351-357.
 5. Laytin AD, Dicker RA, Gerdin M, Roy N, Sarang B, Kumar V, Juillard C. Comparing traditional and novel injury scoring systems in US level-I trauma center: an opportunity for improved injury surveillance in low- and middle-income countries. *J Surg Res* 2017 Jul;215:60-66.

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