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Original article

Probability of Survival in Thoracic Trauma: Comparative Analysis of 100 Patients Attended in a Reference Hospital at Aracaju/SE

Helder S. Gonçalves [1], Mateus L. Rezende [1], Isadora P. Urquieta [2], Leda M. D. F. Trindade [3], Flavio L. D. Cabral [3]

[1]Medical Student, Tiradentes University, Aracaju/Sergipe, Brazil.
[2]Medical Student, University Federal of Sergipe, Aracaju/Sergipe, Brazil.
[3]Department of Medicine, Tiradentes University, Aracaju/Sergipe, Brazil.

*Corresponding author: Helder S. Gonçalves; *heldermd2111@hotmail.com*

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Abstract

Background: Trauma is an injury characterized by structural alterations or physiological imbalance, resulting from acute exposure to some form of energy. Annually, about 5.8 million people die from trauma in the world. In Brazil, around 484,917 people died from external causes in 2016. Among the types of trauma, thoracic trauma is an important cause of death, existing multiple pathologies and association with avoidable causes of death if there were adequate care. Trauma scores have been developed and revised over the years to predict the likelihood of survival for these patients and guide healthcare teams' strategies. ***Methods:*** observational, prospective, quantitative study of victims of thoracic trauma who were admitted to Hospital João Alves Filho in Sergipe, based on the collection of clinical and demographic data. ***Results:*** from the sample of 100 patients, the mean age was 39.32 years, with 85.0% being male. 53% were diagnosed with blunt trauma, of which 33% were victims of traffic accidents; 47% penetrating trauma, being 26% by cold weapons and 21% by firearms. The average survival of these patients was 93.2%. Concomitant lesions were observed in 62.0% of the cases, 45% in the extremities and 45% in the head and neck. ***Conclusion:*** the profile of trauma victims were men between 20 and 39 years old, due to blunt trauma caused by a car accident, with a high probability of survival and associated injuries in other body segments.

Keywords: ***Thorax; Trauma; Lung injuries; Trauma severity indices; Injury severity scale.***

Introduction

Trauma, according to the American College of Surgeons Committee on Trauma (ACS COT), can be defined as an injury characterized by structural alterations or physiological imbalance, resulting from acute exposure to various forms of energy: mechanical, electrical, thermal, chemical or radioactive, superficially affecting soft tissues and/or damaging noble and deep structures in the body [1].

Annually, according to the World Health Organization (WHO), about 5.8 million people die from trauma in the world [2]. In Brazil, 484,917 died from external causes in 2016, 30% of these from traffic accidents, which corresponds to the third leading cause of death in the country [2-3]. Studies estimate that care for each victim of a serious car accident costs an average of R$ 100,000 reais to the public coffers [4-5]. In polytrauma patients, approximately 50 - 58% are affected by a severe thoracic injury [7-9] and it is estimated that approximately one third of patients die before receiving hospital care[10-12].

Thus, the early and accurate assessment of the degree of severity of thoracic trauma is of paramount importance for proper management, from predicting the need for intensive care to future complications, and, therefore, many tools for caring for polytrauma patients have been created, such as trauma scores [2,15].

Trauma scores are currently divided into three categories: Physiological, assessed using the patient's functional parameters, such as the Revised Trauma Score (RTS); Anatomical, based on the severity and extent of the injury, such as the Injury Severity Score (ISS); and Mixed, which mix anatomical and physiological parameters, such as Trauma and Injury Severity Score (TRISS) [2,15].

The RTS was an evolution of the Trauma Score (TS) created in 1981. It is categorized as a physiological score because it evaluates the patient's vital signs patterns in the admission examination [2,16]. Regarding the result of each parameter, there is an equivalent score ranging from 0 to 4 and then applied the formula present in the study. It can vary from 0 to 7.8408 with a weighted increase in the probability of survival [2,15-16].

The ISS is an anatomically based ordinal scale that estimates the severity of trauma based on the Abbreviated Injury Score (AIS), a manual of anatomical descriptors that was first published in 1971 to describe injuries from automobile accidents [16-18]. In the evaluation, the patient is divided into 6 anatomical regions: head and neck, face, thorax, abdomen or pelvic contents, extremities and

pelvic ring and general or external surface [15-16]. Thus, scores ≥ 16 are classified as major traumas, with mortality above 10% [18,19].

Finally, the TRISS was developed by the ACS based on a study initiated in 1982 and published in 1990, called the Major Outcome Study (MTOS), with the objective of obtaining a mathematical method for calculating the probability of survival (PS) of a victim or population after a severe trauma [16]. For the calculation, the RTS and ISS scales are considered, in addition to assessing age and the trauma mechanism [15,16,21].

Each index presents particular limitations of prognostic measurement, since they are statistical approximations. Updates and new models are constantly developed in order to improve the predictive capacity of morbidity and mortality. The purpose of this study is to analyze the epidemiological profile of patients admitted for thoracic trauma at HUSE, a Brazilian hospital located in the state of Sergipe, based on severity criteria, and calculate the probability of survival from these trauma scores.

Materials and Methods

Project and patients

This is an observational, prospective and descriptive study, developed from February 2022 to January 2023, carried out at HUSE, a reference in trauma care in the state of Sergipe.

Instruments and Data Collection

A form pre-elaborated by the authors, based on the literature, was used for data collection, being filled out from an interview at the bedside of the patient. The participant's data were recorded, containing the following variables: Personal Data: name, date of birth, age, gender, origin, place of birth, profession, level of education; and Clinical Data: type of trauma, lesions present on the thorax, lesions present on the body, score on the Glasgow coma scale, respiratory rate and blood pressure in the first service.

Data Processing

Calculation of the Revised Trauma Score (RTS):

The RTS was calculated by the sum of the products resulting from the values of the three components of the RTS, which range from 0 to 4, multiplied by their respective weights, and subsequently the following formula was applied: RTS = 0.9368 (GCS) + 0, 7326 (SBP) + 0.2908 (RF). The final value between 0 and 7.8408, which is an approximation of the graphical limit generated in comparative studies, will be applied to the approximate curve, according to Champion et al., obtaining the probability of survival [22].

Calculation of the Injury Severity Score (ISS):

The injuries evaluated by the examiners during the interview were classified with a numerical code according to the AIS, a trauma score that uses anatomical criteria and the severity of each injury. On examination, the body is divided into 6 anatomical regions, assigning a score from 1 to 6 related to the degree and extent of the lesion. The 3 regions of greatest severity will be chosen and the sum of the squares of these numbers will be performed, obtaining the ISS that will vary from 1 to 75 [18-19].

Calculation of the *Trauma and Injury Severity Score* (TRISS)

The TRISS of the patients was calculated with the results of the RTS and ISS from the formula: $Ps = 1/(1 + e^{-b})$, in which "e" is the base of the Neperian logarithm (2.718282) and "b" is calculated by $b_0 + b_1 * RTS + b_2 * ISS + b_3 * age$. b_0, b_1, b_2, b_3 are different weights that vary according to the type of trauma, blunt or penetrating, according to MTOS [23].

Statistical Analysis

The data was organized in tables and figures, and was presented in the form of absolute numbers. To characterize the studied population, measures of central tendency were calculated, such as mean and standard deviation. The data was consolidated into an Excel spreadsheet and analyzed using the R program, version 4.0.0.

Results

From February 2022 to January 2023, 100 of the total patients admitted to the HUSE were selected for this study according to the predetermined inclusion criteria (**Table 01**).

About the types of trauma, according to the mechanism, they were classified as blunt or penetrating. Among the external causes, most (53.0%) were present in some type of blunt trauma, mainly car accidents (33.0%) and falls (13.0%). Conversely, penetrating trauma added up to 47 (47.0%) cases, mainly due to stab wounds (26.0%) and, in smaller percentages, firearm injuries (21.0%) (**Table 01**).

Table 01: Patients, according to the trauma kinetics, type and sex.

External Causes										
	Transport accidents				Aggression			Other Cinematics		
	Motorcycle accident	Car accident	Run over	Others	CWI	GSW	Others	Level Drop	Sport accidents	Unspecified
Male (N)	18	4	2	4	23	20	3	8	1	2
Female (N)	4	0	1	0	3	1	0	5	0	1
Blunt (N)	22	4	3	4	0	0	3	13	1	3
Penetrating (N)	0	0	0	0	26	21	0	0	0	0
Total (N)	22	4	3	4	26	21	3	13	1	3
Caption: N - absolute frequency. CWI - cold weapon injuries. GSW - gunshot wounds. Source: Autors.										

Of the total number of internal patients, 85 (85.0%) were male and 15 (15.0%) were female, representing a ratio of 5:1. The highest concentration of patients (51.0%) was found in the age groups between 20 and 39 years. In females, the distribution was homogeneous between ages. As for males, higher percentages were observed between 15 and 39 years old, with emphasis on those in the age group between 25 and 35 years old. Ages ranged from 15 to 90 years, with a mean of 39.33±16.45 years, with 38.25±22.7 years for man and for women 45.47±14.8 years (Figure 02).

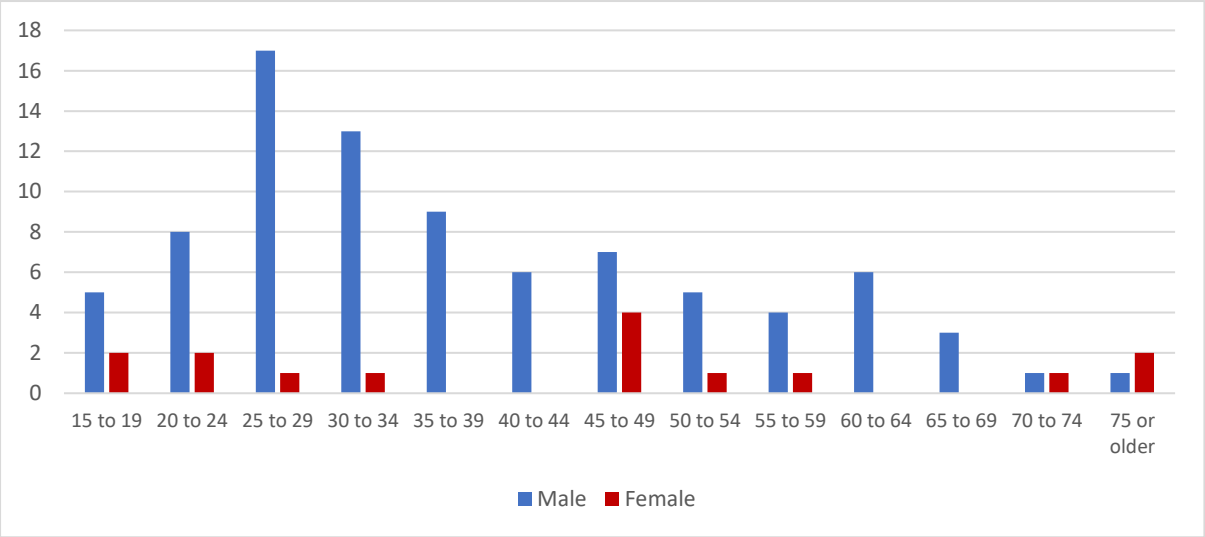

Figure 01: Patients according to gender and age.

Physical aggression (GSW and CWI) were the most frequent events, mainly in the younger population, with a higher incidence between 25 and 29 years old (n=14/14%). Car accidents represented the trauma kinetics that remained present in all age groups (33%), with a higher incidence (5%) between 45 to 49 years and 60 to 64 years (**Figure 02**).

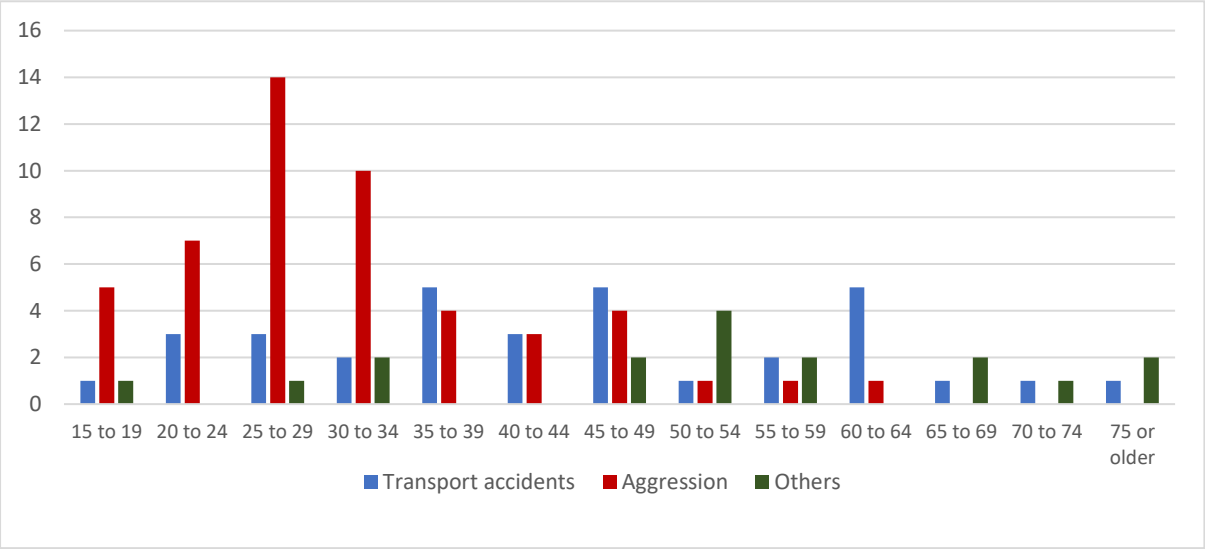

Figure 02: Patients according to age group and trauma mechanism.

Regarding severity, classification and body location, the analysis of injuries in the studied population was based on the AIS. The most concomitantly affected body regions were the extremities or pelvic girdle (45.0%), head and neck (44.0%) and external surface (30.0%). Considering the AIS scores of each injury, it was observed that most injuries were mild to serious or moderate (not life-threatening), AIS 1 to 3. Of the total number of injuries, the highest percentage (33.8%) was for moderate severity (AIS 2); 32.3% for mild (AIS 1) and 24.1% for serious. In addition, 9.7% were AIS 4 and AIS 5 and 6 injuries were not verified (**Table 02**).

The thorax region (46.0%) was injured mainly by penetrating injury. In the other regions, however, it was more frequent in the extremities or pelvic girdle (17.0%), in the head and neck (11.0%) and in the external surface (11.0%). Regarding blunt trauma, after the thorax (32.5%), the head and neck region was the most affected (21.2%), followed by extremities or pelvic girdle (17.8%) (**Table 02**).

Table 02: Distribution and severity of injuries, according to body regions and type of trauma AIS.

	Score (N)						Type of trauma (N)	
	1	**2**	**3**	**4**	**5**	**6**	**Blunt**	**Penetrating**
Head and neck	15	17	8	4	0	0	33	11
Face	12	13	1	0	0	0	19	7
Thorax	19	22	43	13	0	0	51	46
Abdomen or pelvis	4	5	1	5	0	0	7	8
Extremities or waist	18	18	6	3	0	0	28	17
External surface	15	12	3	0	0	0	19	11
Total	83	87	62	25	0	0	-	-
Caption: 1: Minor. 2: Moderate. 3: Severe/Not Life Threatening. 4: Severe/ Life Threatening. 5: Critical/Survival uncertain. 6: Maximum. AIS: Abbreviated Injury Score. Source: Authors.								

From the point of view of the clinical evaluation for the use of the RTS, when the GCS was evaluated, 69% had the maximum score, blood pressure levels 83% and respiratory rate 71%. There were only two cases of GCS 3 and one case of respiratory rate between 1 and 5 bpm.

In victims of blunt trauma, it obtained an average of 6.90 ± 1.33, ranging from 2.98 to 7.84, and in victims of penetrating trauma, it obtained an average of 7.17 ± 1.08, ranging from 3.80 at 7.84. It is noteworthy that most patients (91.0%) scored 5 or more on this scale, with a survival rate above 80.7% (**Table 03**).

It was observed that the pattern of distribution by severity in each type of trauma was similar, however, penetrating trauma tended to be more severe. The majority (68.0%) had an ISS below 15 regardless of the type of trauma, with a p-value <0.05, showing statistical significance. In addition, the average obtained in blunt trauma was 11.23 with a standard deviation of 5.51, ranging from 1 to 24, while in penetrating trauma it was 15.30 with a standard deviation of 10.29, ranging from 1 to 41. Also, no patients with ISS greater than or equal to 25 were observed (**Table 03**).

Addressing the TRISS, the majority (91.0%) of the patients had a probability of survival greater than 75%. A similar distribution in the two trauma groups stands out, and that only four patients had a survival probability of less than 50%, with none below 25%. There was no statistically significant difference when comparing the probability of survival between genders and type of trauma. (**Table 03**).

Table 03: Scores referring to trauma scales

	Sex (N)		**Type of trauma (N)**		
	Male	**Female**	**Blunt**	**Penetrating**	
Patients according to RTS score, sex and type of trauma.					
RTS (N)					PS (%)
< 1	0	0	0	0	2,7 to 7,1
1 to 2	0	0	0	0	7,1 to 17,2
2 to 3	1	0	1	0	17,2 to 36,1
3 to 4	1	1	1	1	36,1 to 60,5
4 to 5	6	0	3	3	60,5 to 80,7
5 to 6	11	1	10	2	80,7 to 91,9
6 to 7	12	3	6	9	91,9 to 96,9
≥ 7	54	10	32	32	96,9 to 98,8
Statistic Data					
Total	85	15	53	47	100
Mean	7	7,17	6,9	7,17	7,02
Standard Deviation	1,23	1,18	1,33	1,08	1,22
Mínimum	2,98	3,8	2,98	3,8	2,98
Maximum	7,84	7,84	7,84	7,84	7,84
Amplitude	4,86	4,04	4,86	4,04	-
Median	7,84	7,84	7,84	7,84	7,84
Quartile 25	6,53	6,86	5,97	6,86	6,61
Quartile 75	7,84	7,84	7,84	7,84	7,84
P-value*	0,174793		0,833463		
Patients, according to ISS score, sex and type of trauma.					
ISS (N)					Total (N)
1 to 8	18	5	17	6	23
9 to 15	39	6	22	23	45
16 to 24	20	4	14	10	24
25 to 40	4	0	0	4	4
41 to 49	4	0	0	4	4
50 to 74	0	0	0	0	0
75 or older	0	0	0	0	0
Statistic Data					
Mean	13,54	10,87	11,23	15,3	13,14
Standard Deviation	8,71	5,52	5,51	10,29	8,36
Mínimum	1	1	1	1	1
Maximum	41	21	24	41	41
Amplitude	40	20	23	40	40
Median	10	12	10	11	10
Quartile 25	9	6	6	9	9
Quartile 75	17	15	7	18,5	17
P-value*	0,666		0,0085		
Patients according to the TRISS score, sex and type of trauma.					
TRISS (%)					Total
< 25	0	0,0	0	0,0	0
25 to 50	4	0,0	1	3,0	4
50 to 75	4	1,0	3	2,0	5

75 to 100	77	14,0	49	42,0	91
N Total	85	15,0	53	47	100
Statistic Data					
Mean	92,92%	94,90%	94,26%	92,05%	93,22%
Standard Deviation	13,21%	10,90%	9,57%	15,77%	12,91%
Mínimum	35,84%	55,00%	49,56%	35,84%	35,84%
Maximum	99,61%	99,25%	99,58%	99,61%	99,61%
Amplitude	63,77%	44,25%	50,02%	63,77%	63,77%
Median	97,93%	98,43%	97,84%	98,68%	98,01%
Quartile 25	93,86%	97,55%	94,61%	94,46%	93,10%
Quartile 75	99,07%	98,93%	98,87%	99,07%	99,07%
P-value*	0,500714		0,665485		

Caption: N - Absolute Frequency. PS - Probability of Survival. RTS - Revised Trauma Score. ISS - Injury Severity Score. TRISS - Trauma Score and Injury Severity Score. P-value* - Chi-squared test. Source: Authors.

Discussion

The present study showed that thoracic trauma is more frequent in young adults, between 20 and 39 years old, and males, in 85.0% of the cases. Similar results were found by Zanette et al, who evaluated 119 patients in a reference hospital in Foz do Rio Itajaí, noting that 70.5% of the patients were men aged between 30 and 44 years, with an average of 39.98 years [10] Naufel Junior et al described results consistent with ours, when analyzing the epidemiological profile of victims of thoracic trauma in Curitiba, where 83.7% were male aged between 15 and 29 years in a population of 98 patients [13].

Other works such as Horst et al, Zhang et al, Ludin et al and Pasquali et al, who studied 2397, 16773 and 4168 patients respectively, corroborate these results, demonstrating a higher incidence in men and age ranging between 30 and 49 years at the time of the thoracic trauma [7,8,11].

Regarding the mechanism of trauma, the proportion between blunt and penetrating trauma was close, with 53.0% and 47.0% respectively, which was equivalent to Horst et al, in Germany, who, among the total number of cases, 93,4% suffered blunt injuries and 4,5% penetrating injuries; with Zanette et al, 89.0% blunt and 11.0% penetrating; and with Ludin et al, in Sweden, who observed 84.0% were blunt trauma [7,8,10].

In blunt trauma, Zhang et al reported that 42,0% of the injuries were due to transport accidents, 14,5% due to falls from heights and 5,8% due to assaults; similar to the findings by Zanette et al, 47.8% due to car accidents, 26,8% to falls from high ground and 7,5% to physical aggression, corroborating our work [10,11]. As for penetrating trauma, there was a predominance of wounds originating from melee weapons, data consistent with recent studies [7,10].

Unlike some studies [11,25] that reported a predominance of trauma restricted to the thorax, there was a higher incidence of injuries associated with thoracic trauma (62.0%), similar to Naufel Junior et al, with a finding of 69,4% in their sample [13]. According to Horst et al, 24,2% of the patients had concomitant lesions in the extremities, 18,8% in the skull and 10,0% in the abdomen, while Benhamed et al reported 75.2% in the extremities, 49,0% in the skull and 27,4% in the abdomen, in a total of 17,6346 patients studied. This data is consistent with what was presented in this research, 45,0% in the extremities and followed by 44,0% in the head and neck. However, with more severe injuries in the abdomen and head and neck region by AIS [8,26].

Analyzing the RTS variable, it was observed that they reached predominantly high scores, with a high degree of probability of survival, equivalent to the score found in the studies by Carrapateira et al, carried out in Campo Grande with 196 patients, where the average of the RTS score obtained was 6,55, and by Gunning and Leenen in the Netherlands, with a mean of 7,31 in a total of 10.235 patients studied. Likewise, Alvarez et al found high RTS scores with the probability of survival ranging between 7,84 and 5,49, in a total of 196 victims of traffic accidents. It is believed to be related to the fact that the victims did not suffer critical or maximum injuries [2,27,28].

As for the ISS, values < 16 are evident in most participants (68.0%), with a mean score of 13,14 ±8,36. Zhang et al presented results that are similar to ours, where 4.168 patients were analyzed in a Chinese hospital, with an average of 13,7 ± 8,2 [11]. The median ISS was 4, ranging from 0 to 9, in a study carried out by Pasquali et al. al, a low score in relation to the study presented. On the other hand, in the research by Horst et al, they presented an average value of 20,7 [8,24].

Calculating the TRISS, eighty-seven of the patients had a probability of survival above 90%, similar to the results of Carrapateira et al, who found that 85,2% of the patients studied had a probability of survival between 98 and 99% [27]. In the Intensive Care Unit in Gyeongsang, Korea, Moon et al evaluated 228 patients and obtained a lower probability of survival than our study, a median of 49,4%, ranging from 24,5 to 75,5%, but only included severe patients with ISS > 18 [29].

It is worth noting that male victims of blunt trauma in our study had a lower survival rate than female victims of penetrating trauma. Added to this, both male gender and blunt trauma can be related to risk factors, however, when statistical comparisons were performed, there was no statistically significant probability in the comparison to evidence this hypothesis.

One of the explanations for this can be given by the limitation of the sample. Therefore, we recommend the continuation of more studies with a larger number of patients in order to better investigate this profile and find data that corroborate the hypotheses in a statistically relevant way. Another limitation present in the study was the methodology adopted for data collection, which demonstrated difficulties in accessing these patients. In an attempt to minimize the impacts of these limitations, more reliable sources were used, such as the medical records of these patients and contact with family members.

Final Considerations

The Conclusions section should clearly explain the main findings and implications of the work, highlighting its importance and relevance. TT mostly affects young male adults, resulting from both penetrating trauma and blunt trauma, with a predominance of stab wounds and car accidents, being associated with injuries in other body regions. The PS, calculated using the trauma, RTS, ISS and TRISS indices, did not show significant variation in this study, being mostly greater than 90% for both sexes. Thus, information obtained can serve as a base for the creation of new strategies for patients who are victims of thoracic trauma, since the trauma indexes can help emergency physicians in the individualization of management by stratifying them in an objective and accurate way.

Ethics approval and consent to participate

The research was approved by the Research Ethics Committee of the Tiradentes University (CEP-UNIT), CAAE: 28342819.3.0000.5371. All signed the ICF and the TFIA, for those under 18 years old.

List of abbreviations

ACS COT: American College of Surgeons Committee on Trauma
AIS: Abbreviated Injury Score
ATLS: Advanced Training Life Support
CEP UNIT: Tiradentes University Ethics and Research Committee
GCS: Glasgow Coma Scale
ICF: Informed Consent Form
ISS: Injury Severity Score
MTOS: Major Outcome Study
PS: Probability of Survival
RF: Respiratory Frequency
RTS: Revised Trauma Score
SBP: Systolic Blood Pressure
TFIA: Terms of Free and Informed Assent
TRISS: Trauma and Injury Severity Score
TS: Trauma Score
TT: Thoracic Trauma
WHO: World Health Organization

Data Availability

The authors declare that this article does not contain data on patients.

Conflicts of Interest

All authors declare that there is no conflict of interest.

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Authors' contributions

HG confirms responsibility for the conception and design of the study, data collection, interpretation of results and preparation of the manuscript. MR and IU confirm having carried out the manuscript writing and data interpretation. FC and LT carefully made corrections and participated in the final draft.

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