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Original Article

Epidemiological profile of chest trauma and predictive factors for length of hospital stay in a hospital in Southern Brazil

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Abstract: Introduction: Thoracic trauma is one of the most common types, corresponding to 10% of the traumas admitted in emergency services. Objective: To analyse epidemiologic aspects of patients diagnosed with chest trauma in a hospital at the south of Brazil and its predictive factor for prolonged length of stay. Methods: We conducted a retrospective cohort involving patients who were victims of chest trauma. They were described by the International Classification of Diseases (ICD) from S20 to S29 admited in a regional hospital in Southern Brazil, from January 2008 to December 2018. The analysed variables were: sex, age, ICD, type of trauma, complication, need for intensive care unit (ICU), mechanical ventilation (MV) and oxygen therapy (O_2), scores on Injury Severity Score (ISS) and Thoracic Trauma Severity Score (TTSS) and outcomes length of stay and death. Results: 121 patients were evaluated, with median age 47.0 (35-0-58.5) years, where 84.3% being of them were male. Blunt trauma had a higher prevalence with 85.1%, with the most frequent complication being spine fractures (30.4%), followed by rib fractures (23.2%) and pneumothorax (16.8%). There was need of ICU in 14%, use of O_2 in 30.6% and need of MV in 5.8%. The median length of stay was 6.0 (4.0-10.5), and death as an outcome was found in only 1.7%. Relying on the TTSS, the median (p25-p75) found was 3.0 (2.0-5.0) points and the ISS score was 4.0 (0.0-9.0). If observing patients with a length of stay ≥ 6 days, there were an association with the female gender, need of ICU, O_2 and MV, ISS scores, and TTSS scores in the categories who involved pleural commitment and minor PaO_2/FiO_2. Conclusion: Most of the victims were male young adults with low mortality. The TTSS and ISS were found to be adequate predictors of prolonged length of stay.

Keywords: Thoracic Injuries, injury severity score, prognosis, length of stay, mortality

Introduction

Thoracic trauma is one of the most common types, corresponding to 10% of the traumas admitted in emergency services [1]. It affects mainly young men, between 20 and 30 years old [2], and is considered an important avoidable cause of death, because it is generally caused by automobile accidents and injuries caused by white weapons and firearms [3].

Thoracic trauma can be classified as open (penetrating) and closed (blunt), the latter being more prevalent, with 90% of cases. In general, they present a low probability of surgical intervention, however the characteristics of the injury will determine the severity [4]. For this reason, trauma management and recognition of the thoracic injury is essential for a good result. Initial resuscitation and management of the traumatized patient are based on Advanced Trauma Life Support (ATLS) protocols [5].

The most frequent chest traumas are fractures of ribs, cardiac, aorta, airways and diaphragm injuries [6]. Traumas with higher risk of death should be excluded or treated immediately: airway obstruction, hypertensive pneumothorax, open pneumothorax, massive hemothorax and cardiac tamponade [7].

In order to classify the risk and estimate the prognosis of the traumatized patient, indicators of severity are used, based on screening of clinical signs [8, 9]. The current standards available for assessing traumatic lesions are broad. There is the Thoracic Trauma Severity Score (TTSS), a scoring system to predict complica-

tions from thoracic trauma and intra-hospital mortality. The score is based on anatomical and functional parameters, such as patient age, resuscitation parameters and chest radiological evaluation [10].

There is also the Trauma and Injury Severity Score (TRISS), a mixed system that predicts mortality using physiological and anatomical criteria, through two specific indexes, the Injury Severity Score (ISS) and the Revised Trauma Score (RTS). The ISS evaluates the anatomic part [11] and the RTS uses some physiological signs and a combination of the patient's age [9, 11]. The TRISS methodology showed great improvement in the quality of patient care, being today considered the gold standard in the evaluation of severe trauma victims [12].

In addition to stratifying the risk of severity and mortality [13, 14], trauma screening scores can also serve to identify patients with longer hospitalization. Few studies have aimed to relate the length of hospital stay with the characteristics of chest trauma [15-17].

Thus, the objective of this study was to describe the epidemiological profile of victims of thoracic trauma admitted to a hospital in southern Brazil and the predictive factors for length of hospital stay.

Methods

We conducted a retrospective cohort. The study population were patients admitted to Nossa Senhora da Conceição Hospital (HNSC), located in southern Brazil, (Tubarão-SC). The HNSC is a regional, tertiary hospital that serves a population of approximately 400,000 inhabitants.

Inclusion criteria

The study included the medical records of all patients who suffered isolated chest trauma and were hospitalized at HNSC from 01/01/2008 to 13/12/2018. We include the diagnoses according to the International Classification of Diseases (ICD) [18]:

- S20 Superficial injury of thorax.
- S21 Open wound of thorax.
- S22 Fracture of rib (s), sternum and thoracic spine.
- S23 Dislocation, sprain and strain of joints and ligaments of thorax.
- S24 Injury of nerves and spinal cord at thorax level.
- S25 Injury of blood vessels of thorax.
- S26 Injury of heart.
- S27 Injury of other and unspecified intrathoracic organs.
- S28 Crushing injury of thorax and traumatic amputation of part of thorax.
- S29 Other and unspecified injuries of thorax.

Exclusion criteria

Incomplete medical records, non-traumatic or polytrauma cases and those under 18 years old were excluded from the study.

Ethical statement

This study was approved by the Research Ethics Committee (REP) of the University of Southern Santa Catarina (UNISUL), through the Brazil platform with opinion 3,461,543 on July 18, 2009. The informed consent form was waived because only information from the electronic records was collected and the patients were not hospitalized during the study period.

Variables

The independent variables were age, gender, type of trauma, hospitalization diagnosis, need for mechanical ventilation (MV), oxygen therapy (O_2) and intensive care unit (ICU), ISS score, TTSS score, complications and death.

The dependent variable was length of stay (LOS).

Data analysis

The data processing and analysis method were done through storage in a database created with the help of the Excell® software, and later were exported to the SPSS 20.0® software. The data were presented through absolute numbers and percentages, measures of central tendency and dispersion (median e interquartile range). For the outcome length of stay < 6 days or ≥ 6 days, it was calculated the prevalence ratio by the Poisson regression with robust variance. In the multivariate analysis the variables with $P < 0.2$ were considered. A 95% confidence interval was considered, with a 5% statistical significance.

Results

Epidemiological profile

A total of 142 medical records were analyzed, excluding the cases of individuals under 18 years old (13), hospitalized for vertebroplasty (5), hospitalized for pain (1), medullary compression (1) and postoperative heart surgery (1), totaling 121 patients. Of these, 102 (84.3%) were men with a median (p25-p75) of 47.0 (35.0-58.5) years, with the main diagnosis being rib, sternum and thoracic spine fractures.

The most frequent ICD was S22 Fracture of rib(s), sternum and thoracic spine, with 44 (36.3) cases, followed by S20 Superficial injury of thorax, with 33 (27.3) individuals. The most frequent type of trauma was blunt, with a prevalence of 103 (85.1). The length of stay had a median (p25-p75) of 6 days (4.0-10.5). The most frequent outcome was hospital discharge, occurring in 119 (98.3) of the cases. More information can be seen in **Table 1**.

TTSS and ISS scores

Regarding the TTSS score, the median (p25-p75) found was 3.0 (2.0-5.0) points, with 96 (79.3%) individuals between 0 and 5 points, 23 (19.0%) between 6 and 10 points and only 2 (1.7%) with scores between 11 and 15, The median (p25-p75) of the ISS score was 4.0 (0.0-9.0). **Table 2** shows the frequencies of each TTSS category.

Chest trauma and predictive factors for length of hospital stay

In the comparison with the length of stay ≥ 6 days, the associated variables were female gender, ICU, 0_2, MV, score on the ISS scale, and in the TTSS categories: hemothorax or unilateral hemopneumothorax and PaO_2/FiO_2 between 200 and 300 and between 150 and 200 (**Table 3**).

Based on the variables obtained during hospitalization, a multivariate model was proposed, as shown in **Table 4**.

Discussion

The sample profile of the present study shows a higher prevalence of male victims with a median age around 47 years, similar to the study Zhang *et al.* [19], which retrospectively evaluated 4168 patients in a Chinese hospital. Other studies such as Veysi *et al.* [20], Chrysou *et al.* [16] and Baru *et al.* [21] confirm the greater presence of men in this type of trauma and mean age, also similar, ranging between 40 and 49 years.

The most frequent mechanism of trauma was contusion, as in the study Horst *et al.* [22], where 95.4% suffering blunt trauma and over 80% of the trauma mechanisms were automobilistic or falling. In the Zahran *et al.* study [23], the prevalence was around 70%, a little lower, but still showing a higher frequency of blunt trauma in relation to the penetrating one, as well as in the Baru *et al.* [21] study that had the prevalence of blunt trauma around 65%.

The most frequent complication demonstrated by this study was spine fracture, followed by fracture of ribs and pneumothorax, which was different from the one observed by Tsai *et al.* [24], where it first demonstrates fracture of costal arches, followed by hemothorax and pneumothorax of patients who suffered contused thoracic trauma. The study by Zhang *et al.* [19] showed fractures of ribs being the most frequent injury found, followed by pneumothorax and hemopneumothorax. Anyway, these were also prevalent findings in this study, followed by spinal fracture. The sternum fracture in the present study was similar to the study of Zhang *et al.* [19], with involvement of 1.7% of the victims, while in relation to spinal injury a difference of around 27% was observed in its incidence, the clavicle fracture a difference of 4%.

The need for ICU in this study had a 2% difference from the study of Zhang *et al.* [19], and the use of MV a 4% difference. The prevalence of deaths in both studies was similar (1.7%). In the study of Zahran *et al.* [23], where a cohort of 300 patients from two institutions was carried out, the results were more different, a lower percentage of patients needed to be observed in the ICU (8% difference), required the use of MV 9% more than in the present study and mortality was also higher (8% more). It is important to emphasize that the TTSS severity score was higher in these patients.

Although the mortality was similar to the studies of Zhang *et al.* [19] and Kashkooe *et al.* [15], of 1.7% and 1.21%, the period of hospitaliza-

Table 1. Epidemiological profile of patients with thoracic trauma from a hospital in southern Brazil from 2008 to 2018

	N (%)
Gender	
Male	102 (84.3)
Female	19 (15.7)
Age (years)#	47.0 (35.0-58.5)
ICD	
S20 Superficial injury of thorax	33 (27.3)
S21 Open wound of thorax	26 (21.3)
S22 Fracture of rib(s), sternum and thoracic spine	44 (36.3)
S23 Dislocation, sprain and strain of joints and ligaments of thorax	1 (0.8)
S24 Injury of nerves and spinal cord at thorax level	5 (4.1)
S25 Injury of blood vessels of thorax	1 (0.8)
S27 Injury of other and unspecified intrathoracic organs	2 (1.7)
S29 Other and unspecified injuries of thorax	9 (7.5)
Trauma type	
Penetrating	103 (85.1)
Blunt	18 (14.9)
Complication	
Spine fracture	38 (30.4)
Fracture of costal arches	29 (23.2)
Pneumothorax	21 (16.8)
Hemopneumothorax	17 (13.6)
Subcutaneous emphysema	12 (9.6)
Pleural effusion	10 (8.0)
Hemothorax	8 (6.4)
Lung contusion	7 (5.6)
Clavicle fracture	5 (4.1)
Spinal cord injury	2 (1.7)
Sternal fracture	2 (1.7)
Need	
ICU Hospitalization	17 (14.0)
Oxygen therapy	37 (30.6)
VM	7 (5.8)
Lenght of stay (days)#	6.0 (4.0-10.5)
< 6 days	56 (46.3)
≥ 6 days	65 (53.7)
Outcome	
Discharge	119 (98.3)
Death	2 (1.7)

#median (interquartile range). ICD: International Classification of Diseases.

tion was different in these studies, with 12.3 and 2.85 days, respectively, of length of stay. These results indicate that chest trauma has low mortality, however the hospital therapeutic approach may vary according to the structure of the service.

The TTSS score found in the present study was below that found by Zahran *et al.* [24], where the patients were more severe and 48 of them had TTSS > 16, being associated with higher mortality risk. Different from what was observed in this work, in which no patient obtained this

Table 2. TTSS categories of patients who were victims of thoracic trauma at a hospital in southern Brazil from 2008 to 2018

	n (%)
Rib fractures	
(0) 0	70 (57.9)
(1) 1-3	31 (25.6)
(2) > 3	15 (12.4)
(3) > 3 bilateral	5 (4.1)
Lung contusion	
(0) No	102 (84.3)
(1) unilobar unilateral	14 (11.6)
(2) unilobar bilateral or bilobar unilateral	5 (4.1)
Pleura	
(0) No	76 (62.8)
(1) Pneumothorax	21 (17.4)
(2) Haemothorax or haemo/pneumothorax unilateral	22 (18.2)
(3) Haemothorax or haemo/pneumothorax bilateral	2 (1.7)
PaO_2/FiO_2	
(0) ≥ 400	113 (93.4)
(1) 300-400	5 (4.1)
(2) 200-300	2 (1.7)
(3) 150-200	1 (0.8)
Age (years)	
(0) < 30	19 (15.7)
(1) 30-41	27 (22.3)
(3) 55-70	60 (49.6)
(5) > 70	15 (12.4)

score, being the maximum score 15. In the study of Casas *et al.* [25], 239 patients were evaluated in the emergency department, of these, only 42 were admitted for trauma care. The mean TTSS of these patients was 4.8 ± 1.9 points. The patients with higher scores were those who had complications such as rib fractures, pulmonary contusion and pleural involvement or died [25].

In relation to the ISS score of this study, values were observed below those obtained in Zhang *et al.* [19], which found a mean of 17.5 for a group of patients in the year 2002 and 13.7 for another group in the year 2012. And, in the work of Al Eassa *et al.* [26], analyzing 474 victims of chest trauma in the United Arab Emirates, the median (p25-p75) of ISS was 5 (1-43). In the study of Chrysou *et al.* [16], 41.9% of patients had ISS > 25 and showed a strong association with mortality. In the study of Casas *et al.* [25] in Spain, the mean ISS was 3 ± 5.6 with a variation of 1 to 35 points, only 9 (3.7%) of the patients presented ISS > 15. These findings indicate that the trauma profile of these patients can be varied, depending on the region and hospital structure.

When comparing the variables associated with the length of stay ≥ 6 days, female gender, need for O_2, MV and ICU stay, higher score in ISS, presence of pneumothorax or hemothorax and lower values of PaO_2/FiO_2 were observed. Corroborating the present study, the work of Chrysou *et al.* [16] also demonstrated longer stay in the group with ISS > 25 (14 days versus 9 days). The study by Kashkooe *et al.* [15], which analyzed 14,054 patients with several types of trauma, also showed higher ISS in the group with longer hospitalization, however, differently from the present study, the male gender remained for a longer period of hospitalization. Perhaps, this difference could have occurred due to the sample profile or the cutoff point of only 3 days.

In the multivariate analysis, only female gender, the highest score in the TTSS and the age below the median were related to the length of stay ≥ 6 days. In the study of Sharma *et al.* [17] carried out in the department of general surgery in India, with 110 patients suffering from thoracic trauma alone, it was observed that the TTSS scale is a good predictor for longer length of stay and mortality. It also showed that the higher age was associated with the higher TTSS score. This study did not obtain any TTSS score > 20.

In general, the TTSS score and the ISS are used mainly to evaluate the outcome mortality and probability of survival [10, 12, 17, 26]. Few studies, such as Kashkooe *et al.* [15], Chrysou *et al.* [16] and Sharma *et al.* [17] analyze these scales with the length of stay, like the present study.

Among the limitations of the study, information bias can be described, by collecting secondary selection data, often filled in without the proper quality of information. Also, it is considered that

Table 3. Comparison of the epidemiological profile of trauma patients in the prediction of length of stay < or ≥ 6 days.

	LOS < 6 days	LOS ≥ 6 days	PR (CI-95%)	P
Age (years)	52.0 (37.2-58.7)	44.0 (33.0-59.0)	0.999 (0.996-1.002)	0.593
Gender				0.003
Male	52 (51.0)	50 (49.0)	1.000	
Female	4 (21.1)	15 (78.9)	1.201 (1.064-1.356)	
Trauma				0.735
Penetrating	9 (50.0)	9 (50.0)	1.000	
Blunt	47 (45.6)	56 (54.4)	1.029 (0.872-1.215)	
ICU				< 0.001
Yes	1 (5.9)	16 (94.1)	1.319 (1.210-1.439)	
No	55 (52.9)	49 (47.1)	1.000	
O_2				< 0.001
Yes	9 (24.3)	28 (75.7)	1.220 (1.095-1.358)	
No	47 (56.0)	37 (44.0)	1.000	
MV				< 0.001
Yes	0 (0.0)	7 (100.0)	1.326 (1.247-1.409)	
No	56 (49.1)	58 (50.9)	1.000	
TTSS[#]	3.0 (2.0-5.0)	4.0 (2.5-6.0)	1.018 (0.995-1.041)	0.129
ISS[#]	4.0 (0.0-9.0)	9.0 (0.0-10.0)	1.009 (1.002-1.017)	0.019
Rib fractures				
0	33 (47.1)	37 (52.9)	1.000	
1	14 (45.2)	17 (54.8)	1.013 (0.884-1.161)	0.853
2	7 (46.7)	8 (53.3)	1.003 (0.837-1.203)	0.973
3	2 (40.0)	3 (60.0)	1.047 (0.792-1.384)	0.748
Lung contusion				
0	50 (49.0)	52 (51.0)	1.000	
1	5 (35.7)	9 (64.3)	1.088 (0.922-1.284)	0.318
2	1 (20.0)	4 (80.0)	1.192 (0.971-1.454)	0.093
Pleural				
0	40 (52.6)	36 (47.4)	1.000	
1	11 (52.4)	10 (47.6)	1.002 (0.851-1.180)	0.984
2	4 (18.2)	18 (81.8)	1.234 (1.098-1.387)	< 0.001
3	1 (50.0)	1 (50.0)	1.018 (0.637-1.626)	0.941
Age (years)				
0	6 (31.6)	13 (68.4)	1.000	
1	13 (48.1)	14 (51.9)	0.902 (0.756-1.075)	0.247
3	33 (55.0)	27 (45.0)	0.861 (0.740-1.002)	0.053
5	4 (26.7)	11 (73.3)	1.029 (0.860-1.231)	0.753
Pao_2/FiO_2				
0	55 (48.7)	58 (51.3)	1.000	
1	1 (20.0)	4 (80.0)	1.189 (0.970-1.459)	0.096
2	0 (0.0)	2 (100.0)	1.322 (1.233-1.405)	< 0.001
3	0 (0.0)	1 (100.0)	1.322 (1.244-1.405)	< 0.001

[#]median (interquartile range). LOS: Length of stay. PR: Prevalence ratio. CI: confidence interval. ISS: Injury Severity Score. TTSS: Thoracic Trauma Severity Score. MV: mechanical ventilation. O_2: oxygen therapy. ICU: intensive care unit.

victims who have suffered severe polytrauma (traumatic brain injury-TBI-associated with chest trauma) and have been entered only by the diagnosis of TBI, not being included in the data-

Table 4. Multivariate model for predicting length of stay ≥ 6 days of hospitalized patients victims of thoracic trauma in a hospital in southern Brazil from 2008 to 2018

	PR (CI-95%)	P
Gender		
Female	1.284 (1.135-1.452)	< 0.001
Male	1.000	
TTSS	1.048 (1.021-1.075)	< 0.001
Age (years)	0.994 (0.990-0.998)	0.005

PR: Prevalence ratio. CI: confidence interval. TTSS: Thoracic Trauma Severity Score.

base of the study. Perhaps, this may be one of the reasons for the low mortality of the cases presented.

Conclusion

When analyzing the epidemiological aspects of chest trauma patients, a higher prevalence of young adult men is observed, the majority being blunt trauma. The most frequent complications were spine fractures, costal arches and pneumothorax fractures and, in general, with low TTSS and ISS scores and few cases of death. In the comparison with the length of stay ≥ 6 days, the female gender was observed, age below the median, need for O_2, MV, ICU stay, higher score of ISS and TTSS.

Disclosure of conflict of interest

None.

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