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Accuracy Value Chest Trauma Score and Thorax Trauma Severity Score Predictors Outcome in Thoracic Trauma Patients at Dr. Mohammad Hoesin General Hospital Palembang

Triyanto Amrisal Mohammad[1], Ahmat Umar[2*], Theodorus[3]

[1] Resident General Surgery, Universitas Sriwijaya, Palembang, Indonesia
[2] Consultant Thoracic and Cardiovascular Surgery, Dr. Mohammad Hoesin General Hospital, Palembang, Indonesia
[3] Lecturer Staff of Medical Pharmacology, Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia

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***Corresponding author:**
Ahmat Umar

E-mail address:
umarahmat04@gmail.com

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A B S T R A C T

Background: Thoracic trauma is the third most common cause of death from trauma, after head and spinal cord injuries. There are several trauma scales that are used globally but because of the difficulty of applying multiple scores, and the use of scores that are found to be less significant. A guideline is needed that can be used as a national system, especially in developing countries, so as to facilitate the assessment and management of thoracic trauma patients. This study aimed to determine the accuracy of the Chest Trauma Score (CTS) and Thorax Trauma Severity Score (TTSS) as outcome predictors in blunt thoracic trauma patients at Dr. Mohammad Hoesin General Hospital Palembang. **Methods:** Accuracy test by comparing 2 scoring systems, namely CTS and TTSS in thoracic trauma patients at Dr. Mohammad Hoesin General Hospital Palembang. Variable analysis used bivariate analysis. If the scale used is nominal, then a table with the kappa test is used. If the scale used is ordinal and interval, it must be changed to a nominal scale by assessing the ROC cut point. Comparison of examination results is known by means of assessment of correlation, accuracy, sensitivity, specificity, positive predictive value, and negative predictive value. **Results:** The kappa coefficient value of CTS and TTSS is 0.743 (p=0.000). The TTSS score has a sensitivity of 80%, specificity of 94.1%, a positive predictive value of 33.3%, a negative predictive value of 3% and an accuracy value of 92.3%. The CTS score has a sensitivity of 100%, a specificity of 67.6%, a positive predictive value of 68.7%, a negative predictive value of 0% and an accuracy value of 71.8%. There was a significant relationship between length of stay with CTS ≥4 (p=0.009) and TTSS ≥11 (p=0.023). There was a significant relationship between the need for ventilator use with a CTS ≥4 (p=0.033) and a TTSS ≥11 (p=0.002).
Conclusion: TTSS and CTS are strong predictors of mortality in thoracic trauma patients.

1. Introduction

Trauma has been recognized as a leading cause of death and disability worldwide over the past few decades.[1] In Indonesia, trauma is the leading cause of death in the 15-24 year age group and the second most common cause of death in the 25-34 year age group.[2] Thoracic trauma is the third most common cause of death from trauma, after head and spinal cord injuries, and is reported as 10% of total trauma cases, with mortality varying from 10% to 60%.[3] Approximately 2/3 of the patients experience thoracic trauma of varying severity from simple rib fractures to penetrating cardiac injuries or tracheobronchial obstruction. Mortality will certainly decrease if accompanied by proper diagnosis and treatment.[4]

Several studies have been conducted with the aim of evaluating factors that predict morbidity and mortality in thoracic trauma, but only a few have finally developed a scoring system for this condition.[5-6] The need for a universal system for thoracic trauma

is needed to identify critical factors, predict patient outcome, the timing of intervention, the need for intensive care, and communicate with family.[3]

There are several trauma scales used globally, such as based on anatomy, namely the Abbreviated injury scale (AIS), Injury severity score (ISS), New injury severity score (NISS), Organ injury scale (OIS), Anatomic profile, and International Classification of Diseases (ICD-9) Injury Severity Score (ICISS). Based on physiology, namely Revised trauma score, Glasgow coma score, and APACHE scoring (Acute physiology and chronic health evaluation (APACHE I, II, III). Combination of both anatomical and physiological scores, namely trauma and injury severity scores (TRISS) and A severity characterization of trauma (ASCOT).[7]

The difficulty of applying multiple scores, as well as the use of scores that were found to be less significant in helping to predict outcomes or resource constraints, has led to the absence of a universally used scoring system. For example, the APACHE score does not focus much on measuring thoracic trauma conditions. Chen et al. found that the Chest Trauma Score can predict the likelihood of poor outcomes such as complications and mortality in thoracic trauma patients if the CTS is 5. In addition, this score tends to be more reliable because it focuses on the pathogenesis of thoracic trauma with the appearance of disturbances. Ribs resulting from thoracic trauma[5] Harde et al. d In his study, 30 patients were divided into two groups, namely those with CTS <5 (15) and CTS 5 (15). CTS 5 was statistically significantly associated with a high incidence of pneumonia (P = 0.046), increased need for mechanical ventilation (P = 0.025), and death (P = 0.035) in thoracic trauma with a sensitivity of 87.5% and specificity of 68%.[3]

In 2000, Pape et al. developed a new score, the thorax trauma severity score (TTSS), which combines patient-related parameters with anatomical and physiological parameters. TTSS consists of five parameters; age, PaO2/FiO2, pleural injury, pulmonary construction, and rib fracture, and scores range from 0 to 25 points. The thoracic trauma severity score (TTSS) is appropriate for the assessment of bone and parenchymal injuries and considers physiological parameters. TTSS is a better predictor of thoracic trauma-related complications at the time of admission in an emergency using the available parameters, namely chest X-ray and arterial blood gases.[8,9] The study by Zahran et al. found that the outcome of thoracic trauma patients could be predicted based on the thoracic trauma severity score. A score of 7 points or more is associated with increased morbidity and mortality, and a score of 20 points or more predicts a fatal prognosis and prolonged mechanical ventilation.[10]

For this matter, a guideline is actually needed that can be used as a national system, especially in developing countries, so as to facilitate the assessment and management of thoracic trauma patients regarding complications and their prognosis. Therefore, the authors decided to analyze the accuracy of the use of the Thorax Trauma Severity Score as a Predictor Outcome in Thoracic Trauma Patients at the Dr. Mohammad Hoesin General Hospital Palembang.

2. Methods

The accuracy test by comparing 2 scoring systems, namely CTS and TTSS, in thoracic trauma patients at Dr. Mohammad Hoesin General Hospital Palembang was carried out in this study. Consecutive sampling was carried out using data taken from the patient's medical record. All study samples aged 18 years who were diagnosed with blunt thoracic trauma indicated hospitalization or hospitalization in the surgical ward of RSMH Palembang. In the medical records of the patients who were the sample, there was data that became universal variables in the form of age and gender. Other variables are Chest Trauma Score (CTS) and Thorax Trauma Severity Score (TTSS) and mortality. Patients with indications for hospitalization, other significant bodily injuries that could pose a threat of death, and who refused to participate were excluded from this study. Data taken from the patient's medical record will be analyzed using the SPSS 25.0 application. Consists of univariate and

bivariate analysis.

If the scale used is nominal, then a table with the kappa test is used. If the scale used is ordinal and interval, it must be converted to a nominal scale with the value of the ROC intersection. Comparison of examination results is known by means of assessment of correlation, accuracy, sensitivity, specificity, positive predictive value, and negative predictive value. Significance was determined if $p < 0.05$. The research results are presented in the form of a table which is then explained in the form of a narrative. This research has been approved by the Health Research Ethics Committee of the Mohammad Hoesin Central General Hospital and the Faculty of Medicine, Sriwijaya University, Palembang, Indonesia.

3. Results

Univariate characteristics describe the distribution of the risk factors and complications studied (Table 1). From table 1 it is known that in this study, the average age was 39 years and male (82.1%).

Table 1. General characteristics of research subjects

General Characteristics	n (%)
Age (years) (mean±SD)	39.2±16.1
Gender	
Male	32 (82.1)
Female	7 (17.9)

Clinical characteristics of study subjects based on thoracic trauma score, length of stay hospitalization, ventilatory requirements, and mortality. From table 4.2, it is known that the average CTS score is 3.9±2.2, and the TTSS score is 6.4±3.8. More patients were hospitalized for>5 days (56.4%), with the average length of stay in the hospital in the study being 5.1 ± 2.9 days, with a relatively low need for a ventilator (16.4%). The mortality rate for thoracic trauma was 12.8% in this study.

Table 2. Clinical characteristics of research subjects

General Characteristics	n (%)
CTS Score	3.9±2.2
TTSS Score	6.4±3.8
Length of Hospitalization < 5 days ≥ 5 days	 17(43.6%) 22 (56.4%)
Need for Ventilator Mortality	6 (15.4%) 5 (12.8%)

To determine the cut-off score of TTSS as one of the predictors in predicting mortality in thoracic trauma patients was performed ROC analysis from the ROC analysis test, it was found that the cut-off point of the TTSS score was >11 with a sensitivity of 80% and a specificity of 97.1%.

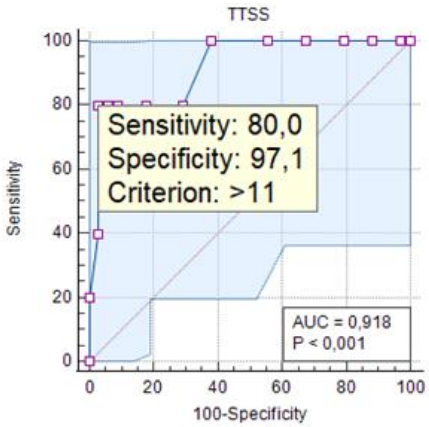

Figure 1. ROC Curve of TTSS score on mortality

In the characteristics of subjects with a TTSS score of ≥11, 4 people (66.7%) died, and 2 people (33.0%) lived. In the characteristics of subjects with a TTSS score <11, 1 person (3.0%) died and 32 people (97.0%) lived.

Table 3. TTSS score on mortality

Subjective Characteristics	Died (%)	Alive (%)	Total (%)
TTSS Score ≥ 11	4 (66.7%)	2 (33.3%)	6 (100%)
TTSS Score <11	1 (3.0%)	32(97.0%)	33 (100%)

Table 3 shows the sensitivity, specificity, and predictive value of the TTSS score. In the table, it is known that the TTSS score has a sensitivity of 80%, specificity of 94.1%, a positive predictive value of 33.3%, a negative predictive value of 3%, and an accuracy value of 92.3%, indicating a very strong level of accuracy statistically.

ROC analysis from the ROC analysis test was performed to determine the cut-off score of CTS as an accurate predictor in predicting mortality in thoracic trauma patients. It was found that the Cut-off Point of the CTS score was at a score of > 4 with a sensitivity of 80% and a specificity of 97.1%.

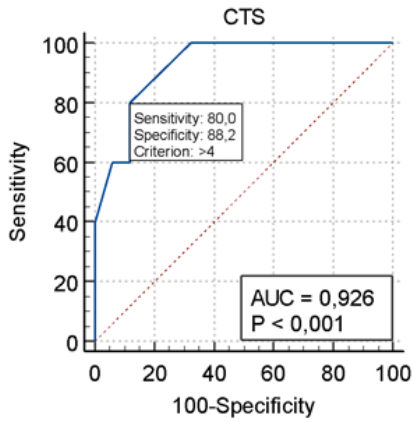

Figure 2. ROC Curve of CTS score on mortality

The characteristics of the CTS score on mortality can be seen in Table 4 In the characteristics of subjects with a CTS score ≥ 4, 5 people (31.3%) died, and 11 people (68.8%) were alive. In the characteristics of subjects with CTS scores <4 all patients were alive (100%).

Table 4. CTS score on mortality

Subjective Characteristics	Died (%)	Alive (%)	Total (%)
CTS Score ≥4	5 (31.3%)	11 (68.8%)	16 (100%)'
CTS Score <4	0 (0%)	23 (100%)	23 (100%)

Table 4 shows the sensitivity, specificity, and predictive value of the CTS score. The table shows that the CTS score has a sensitivity of 100%, a specificity of 67.6%, a positive predictive value of 68.7%, a negative predictive value of 0%, and an accuracy value of 71.8%, indicating a sufficient level of accuracy in statistics.

The statistical assessment of the suitability between the TTSS score and the CTS score is known by looking at the Kappa coefficient value and p-value. The suitability of the TTSS score with the CTS score resulted in a sensitivity of 37.5%, specificity of 100%, a positive predictive value of 100%, a negative predictive value of 30.3%, and a Kappa coefficient value of 0.743 with a p-value of 0.000 implying substantial agreement between the two tests that there is a correlation. This implies that one of the scores can be used as a predictor of mortality in thoracic trauma.

Table 5. Conformity of TTSS score with CTS score

TTSS score	CTS score		kappa coefficient	p
	≥4	<4		
	n (%)	n (%)		
≥11	6 (75)	0 (0)	0.743	0.001
<11	10 (25)	23 (100)		

In table 6, it is known that there is a significant relationship between the length of stay in the score and the CTS score with p = 0.009. A CTS score of 4 indicates a prolonged hospitalization of 5 days in the thoracic trauma patients in this study.

Table 6. Relationship between length of stay and CTS score

Variable	CTS score		p
	≥4	<4	
	n (%)	n (%)	
≥ 5 days	13 (59.1%)	9 (40.9%)	0.009
< 5 days	3 (17.6%)	14 (82.4%)	

In table 7, it is known that there is a significant relationship between the length of stay in the score and the TTSS score with p = 0.023. A TTSS score of ≥11 indicates a prolonged hospitalization of ≥5 days in thoracic trauma patients in this study.

Table 7. Relationship between length of stay and TTSS score

Variable	TTSS score		p
	≥11	<11	
	n (%)	n (%)	
≥ 5 days	6 (27.3%)	16 (72.3%)	0.023
< 5 days	0 (0%)	17 (100%)	

In table 8 it is known that there is a significant relationship between the need for ventilator use and the CTS score with a p-value = 0.033. CTS score ≥4 indicates the need for ventilator use in thoracic trauma patients in this study.

Table 8. Relationship between the need for ventilation and the CTS score

Need a Ventilator	CTS score		p
	≥4	<4	
	n (%)	n (%)	
Yes	5 (83.3%)	1 (16.7%)	0.033
No	11 (33.3%)	22 (66.7%)	

Table 9 shows that there is a significant relationship between the need for ventilator use and the TTSS score with a p-value = 0.002. TTSS score ≥11 indicates the need for ventilator use in thoracic trauma patients in this study.

Table 9. Relationship between ventilator need and TTSS score

Need a Ventilator	TTSS score		p
	≥11	11 <11	
	n (%)	n (%)	
Yes	4 (66.7%)	2 (33.3%)	0.002
No	2 (6.1%)	31 (93.9%)	

4. Discussion

The results of this study concluded that the average age was 39 years and male (82.1%). Trauma has been recognized as a leading cause of death and disability worldwide over the past few decades.[1] In Indonesia, trauma is the leading cause of death in the 15-24 year age group and the second most common cause of death in the 25-34 year age group.[2] This is similar to a study by Zahran et al. (2020) that in thoracic trauma, there were 284 male patients (94.7%) with an average age of 41 years. In addition, the study by nar et al. (2020) revealed that the mean age of thoracic trauma was 52.15 ± 20.3. 29 (25.7%), and the predominance of patients included in this study were men (74.3%).[11]

Clinical characteristics of study subjects are based on thoracic trauma scores, length of stay, need for ventilators, and mortality. From table 4.2, it is known that the average CTS score is 3.9±2.2, and the TTSS score is 6.4±3.8. More patients were hospitalized for>5 days (56.4%) with a mean length of stay of 5.1 ± 2.9 days, and the need for a ventilator was quite low (16.4%). The mean CTS score in Harde's study was in the range from 2 to 12 with a mean score of 5 ± 1,250.[3] The mortality rate for thoracic trauma was 12.8% in this study. Sikander et al., in their study, stated that the mortality rate was 21.3% (n = 17). The average length of hospital stay in the study was 5.3 ± 3.4 days.[12]

Research related to the TTSS score is still few, so the cut-off point is felt to be determined in this study. From the ROC analysis test, it was found that the cut-

off point of the TTSS score was >11, with a sensitivity of 80% and a specificity of 97.1%. From the ROC curve analysis, it was also found that the TTSS score has an *Area Under Curve* of 0.918, which indicates that the TTSS score has a strong mortality predictive ability. The study by Zahran et al. found that the *outcome* of thoracic trauma patients could be predicted based on the thoracic trauma severity score. A score of 7 points or more is associated with increased morbidity and mortality, and a score of 20 points or more predicts a fatal prognosis and prolonged mechanical ventilation.[10] Casas et al. in their study, actually found that the area under the curve for TTSS was significant for predicting complications (0.848) and mortality values (0.856). The TTSS with a cut-off value of 8 points had a sensitivity of 66% and specificity of 94% for predicting complications and 80% sensitivity and 94% specificity for predicting mortality.[13] In 2012, Philipp M et al. suggested a study of chest trauma patient outcomes comparing trauma scoring systems which found that among the scoring systems examined, only TTSS was an independent predictor of mortality. Patients with TTSS > 9 have a 4-fold risk of death.[14] This difference *in cut-off* implies the need for a study with a larger, multicenter sample so that *cut-off* can be used to generalize predictors of mortality in thoracic trauma patients.

The TTSS score in this study had a sensitivity of 80%, specificity of 94.1%, a positive predictive value of 33.3%, a negative predictive value of 3%, and an accuracy value of 92.3%, indicating a very strong statistical accuracy. In Sharma's study, higher TTSS was associated with higher mortality. Similar results seen in the study of Adel Elbaih et al. showed that in TTSS, 33.3% of patients scored 0-5, 26.6% scored 6-10, 20% scored 11-15, 13.3% of patients scored 16-20, and only 6.7% scored ≥21 with the highest mortality rate in high scores. Score 0-5, 2 patients were discharged, and 8 patients were admitted to the inpatient room. With a score of 6-10, 4 patients were treated in the inpatient ward and 4 patients in the ICU. All of those who scored 11-20 were admitted to the ICU, and scores of ≥21-25 were associated with early death in two patients, indicating that higher scores were associated with a higher risk of death, similar to the results of the study of Sharma et al.[15,16]

Research related to the CTS score is also still relatively small, so it is felt that the cut-off point needs to be determined in this study. From the ROC analysis test, it was found that the Cut-off Point of the CTS score was at a score of > 4 with a sensitivity of 100% and a specificity of 67.6%. From the analysis of the ROC curve, it was also found that the CTS score has an Area Under Curve of 0.926, which indicates that the CTS score has a strong ability to predict mortality. This study is similar to that conducted by Harde in that data were collected from 30 patients, and they were divided into two groups, CTS < 5 (15) and CTS 5 (15). The area under the ROC for mortality indicated that the test was acceptable (0.75), and at a CTS score of 5.5, the maximum sensitivity was 87.5% and specificity 68%.[3] In Harde's study, a high total CTS was also significantly associated with mortality (P = 0.035). Early mortality is seen in bilateral multiple internal injuries with large vessels, and refractory respiratory failure is the most common cause of late death. The study by Pressley et al. and Chen et al. showed that a CTS score of 5 had a greater prevalence of mortality [6,17] Chen further emphasized that a CTS 5 was an important independent predictor for the three outcomes separately, namely mortality, pneumonia, and Acute Respiratory Failure.[6] Chen et al. also compared CTS with ISS and chest AIS, and they were found to be insignificant for predicting all three outcomes in the same patient.[6] CTS has thus shown promising results in predicting outcomes in chest trauma and could be useful. However, the unavailability of CT scanning in peripheral rural areas may limit its use. Although CT-Scan is considered the most sensitive for diagnosing pulmonary contusions, chest X-ray can also be used to assess pulmonary contusion in low-resource settings, and thus CTS can be used.[18]

In addition, both the CTS and TTSS scores are known to have a significant relationship with the length of stay in the score. CTS score 4 and TTSS score

11 indicated the prolongation of hospitalization in thoracic trauma patients in this study. Pasquali et al., in a multivariate analysis, the highest score on the TTSS was associated with 6 days of hospitalization.[19] In the study of Sharma et al. conducted in a general surgery department in India, with 110 patients suffering from thoracic trauma alone, it was observed that the TTSS scale is a good predictor of longer hospital stay. This indicates that patients with higher TTSS have a longer hospital stay as compared to patients with lower TTSS scores.[15] Sikander et al. determined the CTS score from several factors such as age, rib fracture, and pulmonary contusion. Rib fractures were found in 72 (90%) patients. The mortality rate was 21.3% (n = 17). Factors that were significantly associated with mortality were age 80 years (p = 0.00), *tension* pneumothorax (p = 0.036), pre-existing cardiopulmonary disease (p = 0.032), blood loss 500 mL (p = 0.004), flail chest (p = 0.018), and CTS score 5 (p = 0.001). The mean length of hospital stay in the study was 5.3 ± 3.4 days. Factors that prolong hospital stay in the previous study where the length of stay was more than five days included pulmonary contusion (p = 0.02), more than two rib fractures (p = 0.004), hemopneumothorax (p = 0.026), pneumonia (p = 0.003), acute respiratory distress syndrome (p = 0.003), and flail chest (p = 0.013).[12]

A significant relationship was also found between the need for ventilator use and CTS and TTSS scores. CTS score ≥4 and TTSS score ≥11 indicated the use of a ventilator in thoracic trauma patients in this study. Severe thoracic injuries impede deep breathing and expulsion of secretions leading to secondary respiratory complications, development of pneumonia, and the need for mechanical ventilation. This was demonstrated in Harde's study because CTS ≥5 was significantly associated with an increased need for mechanical ventilation (P = 0.025) in thoracic trauma.[3] In a study by Pressley et al., high CTS scores are associated with pulmonary complications and are more likely to require intubation. Chen et al. showed that patients with CTS 5 had a greater prevalence of pneumonia and mechanical ventilation.[6,17] In Sharma et al.'s study, 19 patients (17.27%) required ventilator support. Those requiring ventilator support had higher TTSS scores. Thus, there was a significant correlation between TTSS and mechanical ventilation (hours) of patients (p=0.038, r-value 0.477). The higher TTSS score was due to the need for ICU transfer of the patient and the need for mechanical ventilation.[15] The use of a ventilator is associated with the need for ICU care. Bagaria et al. conducted a study that which the mean TTSS of patients who had a fatal outcome was significantly higher than that of patients who recovered. The average ICU stay in patients with a TTSS greater than five was 70% longer compared to patients with a score less than or equal to 5, and the difference was statistically significant (17 days vs. 10.2 days, p = 0.04).[20]

5. Conclusion

The kappa coefficient value of CTS and TTSS is 0.743 with a p-value = 0.000, implying that there is substantial agreement between the two tests that there is a correlation. The TTSS score has a sensitivity of 80%, specificity of 94.1%, a positive predictive value of 33.3%, a negative predictive value of 3%, and an accuracy value of 92.3%, indicating a very strong level of statistical accuracy. The CTS score has a sensitivity of 100%, specificity of 67.6%, a positive predictive value of 68.7%, a negative predictive value of 0%, and an accuracy value of 71.8%, indicating a sufficient level of accuracy in statistics. =0.009) and TTSS ≥11 score (p=0.023). There was a significant relationship between the need for ventilator use with a CTS ≥4 score (p=0.033) and a TTSS ≥11 score (p=0.002).

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