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Accuracy of the Chest Trauma Score (CTS) as a Predictor of Acute Respiratory Distress Syndrome (ARDS) in Blunt Chest Trauma Patients: Single Center Study at Dr. Mohammad Hoesin General Hospital, Palembang, Indonesia

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A B S T R A C T

Introduction: Chest trauma is the third most common cause of death due to trauma worldwide, with a mortality rate reaching 60%. Chest Trauma Score (CTS) is a chest trauma assessment score that can predict patient complications and death, including acute respiratory distress syndrome (ARDS). This study aims to determine the relationship and assess the accuracy of CTS as a predictor of ARDS in patients with blunt chest trauma. **Methods:** Medical records of 32 patients with blunt chest trauma were analyzed. Subjects were assessed for CTS, with components including age, number of rib fractures, presence of bilateral rib fractures, and lung contusion. Data were divided into two groups, CTS<5 and CTS≥5. Data were analyzed to determine the relationship between CTS and ARDS. **Results:** 62.5% of subjects had CTS ≥5 and 37.5% had CTS<5. As many as 68.8% of subjects with blunt chest trauma experienced ARDS. Analysis using the Fischer Exact Test showed that there was a significant relationship ($p<0.05$) between the CTS value and ARDS. The sensitivity of this study was 77.3%, specificity 70%, positive predictive value 85%, negative predictive value 58.3%. **Conclusion:** Statistically there is a significant relationship between the chest trauma score and ARDS, so the chest trauma score is considered accurate as a predictor of ARDS in patients with blunt chest trauma.

1. Introduction

Chest trauma is one of the leading causes of death due to injury worldwide. The mortality rate reaches 60%, making it the third most common cause of death due to trauma after head trauma and extremity injuries. Chest injuries can be caused by various events, such as traffic accidents, falls from heights, stab or gunshot wounds, and chest compression. The impact of chest trauma can vary from minor injuries such as lung contusion to severe injuries involving damage to internal organs, such as the heart, lungs and large blood vessels. Accurate and timely initial assessment of chest trauma patients is essential to determine prognosis and appropriate intervention. This is because chest trauma can cause various serious complications, including acute respiratory distress syndrome (ARDS), hemorrhagic shock, and heart failure. Effective early assessment allows the medical team to identify patients at high risk of complications and provide appropriate interventions to prevent or minimize the risk of death.[1-3]

Chest trauma score (CTS) is one of the most widely used chest trauma assessment scores. CTS was developed in 1987 by Champion and has been validated in various studies to predict mortality and complications in chest trauma patients. This score consists of five components, namely age (years): 1 point for each year over 55 years, Number of rib

fractures: 1 point for each rib fracture, Bilateral rib fractures: 2 points, Lung contusion: 1 point, systolic blood pressure (mmHg): 1 point for every 10 mmHg decrease below 110 mmHg. The total CTS score ranges from 0 to 25. A higher score indicates a more severe chest injury and a higher risk of complications. ARDS is a serious complication that often occurs in chest trauma patients. ARDS is characterized by severe lung inflammation and impaired gas exchange, which can lead to respiratory failure and death. Symptoms of ARDS include shortness of breath, rapid breathing, and decreased blood oxygen saturation. ARDS can be treated with mechanical ventilation and other supportive therapies, but the mortality rate is still high. CTS has been proposed as a predictor of ARDS in chest trauma patients. Previous studies have shown that patients with higher CTS scores have a higher risk of ARDS. This suggests that CTS can be used as a tool to identify patients at high risk of ARDS and enable early intervention to prevent or minimize the risk of this complication.[4-6]

Although CTS has been validated as a predictor of mortality and complications in chest trauma patients, further research is needed to specifically evaluate its accuracy in predicting ARDS. This is important because ARDS is a serious complication with a high mortality rate. More comprehensive research on the relationship between CTS and ARDS may help improve the initial assessment of chest trauma patients and enable more appropriate interventions to prevent or minimize the risk of this complication. Therefore, this study aimed to investigate the relationship between CTS and ARDS in patients with blunt chest trauma. This study will analyze data from hospitalized blunt chest trauma patients to determine whether CTS can be used as an accurate predictor of ARDS.

2. Methods

This research was conducted retrospectively by analyzing medical record data of patients with blunt chest trauma who were treated at Dr. Mohammad Hoesin General Hospital, Palembang, Indonesia between 2022-2024. A retrospective research design was chosen because it allows to collect of data from patients who have been treated in the past, without the need for direct patient intervention. The population of this study was all adult patients (minimum age 18 years) who were treated at Dr. Mohammad Hoesin General Hospital Palembang with a diagnosis of blunt chest trauma between 2022-2024. The sample for this study was patients who met the following inclusion criteria: at least 18 years of age, experienced blunt chest trauma, had complete chest trauma score (CTS) data, and had a diagnosis of ARDS or not. Patients who do not meet the inclusion criteria will be excluded from the study.

Patient data were collected from medical records, including age, gender, mechanism of injury, CTS score, and ARDS diagnosis. Data were collected by trained researchers using previously prepared data collection forms. This form is designed to ensure that all relevant data is collected accurately and completely. Data were analyzed using descriptive statistics to describe patient characteristics, such as age, gender, mechanism of injury, CTS score, and prevalence of ARDS. The Fisher Exact test was used to determine the relationship between CTS and ARDS scores. The sensitivity, specificity, positive predictive value, and negative predictive value of CTS for predicting ARDS were also calculated. This research was conducted following the research ethical principles set out by the Declaration of Helsinki. Research ethics approval has been obtained from the research ethics committee of Dr. Mohammad Hoesin General Hospital Palembang. Patient data is kept confidential and is only used for research purposes.

3. Results

This study involved 32 subjects, with the majority being male (78.1%). The largest age group was <45 years (59.4%), followed by 45-65 years (28.1%) and >65 years (12.5%). In terms of chest injuries, 40.6% of subjects had <3 rib fractures, 40.6% had 3-5 rib fractures, and 9.4% had bilateral rib fractures. Pulmonary contusions occur in 75% of cases, with major and minor unilateral contusions most

frequently occurring (25% each). The majority of subjects (62.5%) had a CTS score ≥5, indicating more severe chest injury. This is consistent with the diagnosis of ARDS in 68.8% of subjects. The relationship between CTS and ARDS was further investigated in subjects with CTS ≥5. The results showed that 53.1% of these subjects experienced ARDS, strengthening the association between CTS scores and ARDS risk in blunt chest trauma patients (Table 1).

Table 1. Distribution of research subject characteristics.

Characteristics	Frequency	Percentage (%)
Gender		
Male	25	78.1
Female	7	21.9
Age (years)		
<45	19	59.4
45-65	9	28.1
>65	4	12.5
Total rib fractures		
<3	13	40.6
3-5	13	40.6
Bilateral	3	9.4
Lung contusion		
Yes	24	75
Unilateral mayor	8	25
Unilateral minor	8	25
Bilateral mayor	4	12.5
Bilateral minor	4	12.5
CTS scores		
<5	12	37.5
≥5	20	62.5
Diagnosis of ARDS		
Yes	22	68.8
No	10	31.3

Table 2 describes the relationship between chest trauma score (CTS) and acute respiratory distress syndrome (ARDS) in 32 patients with blunt chest trauma. In the group of patients with a CTS score ≥5, there were 17 patients (53.1%) diagnosed with ARDS, while only 3 patients (9.4%) did not experience ARDS. This shows that patients with a high CTS score have a greater risk of ARDS compared with patients with a low CTS score. In contrast, in the group of patients with a CTS score <5, only 5 patients (15.6%) experienced ARDS, while 7 patients (21.9%) did not experience ARDS. This suggests that the risk of ARDS in patients with low CTS scores is lower. This result is strengthened by the Fisher Exact Test which shows a statistically significant p-value (0.018). This p-value indicates that there is a significant relationship between CTS and ARDS scores. Overall, table 2 shows that the CTS score can be used as a predictor of ARDS

in patients with blunt chest trauma. Patients with a CTS score ≥5 have a higher risk of ARDS than patients with a CTS score <5. These findings support the aims of the study and may help improve initial assessment and intervention for patients with blunt chest trauma.

Table 2. Relationship between CTS and ARDS.

CTS	ARDS	Not ARDS	P-value
≥5	17 (53,1%)	3 (9,4%)	0.018
<5	5 (15,6%)	7 (21,9%)	
Total	22 (68,8%)	10 (31,3%)	

Table 3 shows the diagnostic performance of the chest trauma score (CTS) for predicting acute respiratory distress syndrome (ARDS) in 32 patients with blunt chest trauma. Sensitivity measures the proportion of patients with ARDS who are correctly identified by CTS. In this table, the sensitivity of CTS for predicting ARDS is 77.3%. This means that of the 22 patients with ARDS, 17 patients (77.3%) were correctly identified by CTS. Specificity measures the proportion of patients without ARDS who are correctly identified by CTS. In this table, the specificity of CTS for predicting ARDS is 70.0%. This means that of the 10 patients without ARDS, 7 patients (70.0%) were correctly identified by CTS. The positive predictive value measures the proportion of patients with a positive CTS result who actually have ARDS. In this table, the positive predictive value of CTS for predicting ARDS is 85.0%. This means that of the 20 patients with positive CTS results, 17 patients (85.0%) actually had ARDS. Negative predictive value measures the proportion of patients with negative CTS results who truly do not have ARDS. In this table, the negative predictive value of CTS for predicting ARDS is 58.3%. This means that of the 12 patients with negative CTS results, 7 patients (58.3%) truly did not have ARDS.

Table 3. Diagnostic accuracy of CTS for predicting ARDS.

Diagnostic test	Value
Sensitivity	77.30%
Specificity	70.00%
Positive predictive value	85.00%
Negative predictive value	58.30%

4. Discussion

Blunt chest trauma, which results from a violent impact on the chest area, is one of the main causes of death and morbidity in trauma patients. This injury can cause a variety of serious complications, including damage to the lungs, heart, and blood vessels. One of the most feared complications is acute respiratory distress syndrome (ARDS), a condition characterized by severe lung inflammation that causes difficulty breathing and lack of oxygen. The mortality rate for blunt chest trauma patients with ARDS reaches 40%, much higher than for patients without ARDS. Therefore, early identification and timely intervention are key to increasing the chances of patient survival. In the midst of this critical situation, the chest trauma score (CTS) emerges as a promising clinical assessment tool for predicting ARDS in blunt chest trauma patients. The CTS, developed in 1989, is a simple scoring system that considers several important clinical variables such as mechanism of injury, patient age, systolic blood pressure, and respiratory rate. Previous studies have demonstrated

the potential of CTS in predicting ARDS. A meta-analysis of 12 studies showed that CTS had a sensitivity of 75% and a specificity of 68% in identifying blunt chest trauma patients at high risk of ARDS. Recent research further strengthens the evidence supporting the use of CTS as an effective ARDS prediction tool. Involving 32 patients with blunt chest trauma, this study showed that CTS had a sensitivity of 77.3%, specificity of 70.0%, positive predictive value of 85.0%, and negative predictive value of 58.3% for predicting ARDS. These findings suggest that CTS can well identify patients with ARDS and differentiate them from patients without ARDS. CTS offers several key advantages that make it an attractive tool for predicting ARDS. CTS is easy to calculate and use, even in stressful environments such as emergency rooms. Research shows that CTS has a fairly high level of sensitivity and specificity for predicting ARDS. The use of CTS can help physicians to identify patients at high risk of ARDS so that early intervention can be undertaken, allocating resources more effectively, providing more accurate information to patients and their families about risks and treatment options. This latest research is an important step in efforts to improve the prediction and management of ARDS in patients with blunt chest trauma. However, there is still much to learn. Further studies with larger samples and more robust designs are needed to confirm these findings and to evaluate the diagnostic performance of CTS in different patient subgroups. In addition, the development of other assessment tools that can be used in conjunction with CTS to improve the accuracy of ARDS predictions should also be considered. Overall, CTS has demonstrated itself to be a valuable tool in predicting ARDS in patients with blunt chest trauma. Its simplicity, accuracy, and clinical utility make it an attractive tool to use in the initial assessment of these patients.[7-10]

Recent research findings regarding the use of the chest trauma score (CTS) to predict acute respiratory distress syndrome (ARDS) in blunt chest trauma patients show strong consistency with the results of previous studies. This further strengthens the validity of CTS as a useful clinical assessment tool in identifying patients at high risk of ARDS. A meta-analysis pooling data from 12 previous studies showed that CTS had a sensitivity of 75% and a specificity of 68% in predicting ARDS. These figures show that CTS was able to identify 75% of patients with ARDS and differentiate them from 68% of patients without ARDS. These high levels of sensitivity and specificity suggest that CTS can be used with sufficient accuracy to detect patients at high risk of ARDS, allowing early intervention and prevention of more severe complications. Other studies have also demonstrated the benefit of CTS in predicting ARDS and mortality risk in chest trauma patients. A study showed that CTS can predict the risk of death in chest trauma patients with ARDS with a high degree of accuracy. These findings suggest that CTS can not only help identify patients at risk for ARDS, but also predict the likelihood of worse outcomes, allowing for more targeted and intensive interventions. The consistency of research findings on CTS and ARDS has important implications for clinical practice. The use of CTS can help physicians more quickly and accurately identify blunt chest trauma patients who are at high risk of ARDS. Early identification of at-risk patients allows early interventions such as fluid therapy and mechanical ventilation that can help prevent or reduce the severity of ARDS. CTS can help physicians prioritize the allocation of limited medical resources to patients who need them most, such as patients at high risk of ARDS. Information about ARDS risk obtained from CTS can help physicians to communicate with patients and their families more clearly and accurately about possible complications and treatment options.[11-13]

The relationship between chest trauma score (CTS) and acute respiratory distress syndrome (ARDS) in blunt chest trauma patients is a complex phenomenon with several contributing factors. The main factor underlying this relationship is the role of the CTS in measuring the severity of chest trauma. Severe chest injuries, such as damage to the lungs, heart, and

blood vessels, are a major risk factor for ARDS. CTS, taking into account variables such as the mechanism of injury and systolic blood pressure, provides a comprehensive picture of the severity of chest trauma. A high CTS score indicates a more severe injury and, therefore, a higher risk of ARDS. In addition to the severity of chest trauma, CTS also considers other clinical variables that may influence ARDS risk. Patient age and systolic blood pressure are two important examples. Older patients and patients with low systolic blood pressure have a higher risk of ARDS, possibly due to age-related decline in pulmonary and cardiovascular function and hypotension. CTS, by including these variables, provides a more comprehensive assessment of ARDS risk by considering individual patient factors. The main advantage of CTS is its simplicity and ease of use. CTS can be calculated quickly in the emergency room, using information that is readily available. This is especially important in critical situations where time is precious and early intervention for ARDS can save lives. The ease of use of CTS allows physicians to promptly assess the risk of ARDS in blunt chest trauma patients and take appropriate steps to prevent or manage this complication. Further research is needed to understand in more depth the mechanisms underlying the relationship between CTS and ARDS. A better understanding of how clinical variables measured by CTS contribute to ARDS risk may aid in the development of more accurate assessment tools and more effective prevention strategies. The association between CTS and ARDS, driven by multiple complex factors, suggests that CTS is a valuable tool in predicting ARDS in patients with blunt chest trauma. Its simplicity, accuracy, and ease of use make it an important tool in the initial assessment and early intervention for ARDS.[14-17]

CTS is designed to assess the severity of chest trauma by considering several key variables such as mechanism of injury, patient age, systolic blood pressure, and respiratory rate. More severe chest trauma, such as direct impact to the chest or penetrating injury, generally results in higher CTS scores, indicating a greater risk of ARDS. Older patients with blunt chest trauma have a higher risk of ARDS than younger patients. CTS considers patient age as a risk factor, so a high CTS score in an elderly patient may indicate a greater likelihood of ARDS. Low systolic blood pressure after chest trauma is an indicator of poor organ perfusion, which may increase the risk of ARDS. CTS takes systolic blood pressure into account, so a low CTS score may indicate a greater likelihood of ARDS. An increased respiratory rate after chest trauma may indicate lung damage and difficulty breathing, which are early symptoms of ARDS. CTS takes respiratory rate into account, so a high CTS score may indicate a greater likelihood of ARDS. In addition to measuring the severity of chest trauma, CTS also considers several other variables that may influence ARDS risk. Patients with comorbid medical conditions, such as heart or lung disease, have a higher risk of ARDS after chest trauma. CTS does not directly account for comorbidities, but high CTS scores in patients with comorbidities may indicate a greater likelihood of ARDS. Injuries to organs other than the chest, such as head injuries or traumatic brain injuries, can also increase the risk of ARDS. CTS does not directly account for other injuries, but a high CTS score in a patient with other injuries may indicate a greater likelihood of ARDS.[18-20]

5. Conclusion

There is a significant relationship between the chest trauma score and ARDS, so the chest trauma score is considered an accurate predictor of ARDS in patients with blunt chest trauma. CTS can be used as an effective tool to predict ARDS.

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