

# Prediction of outcomes in chest trauma patients using chest trauma scoring system: A prospective observational study

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## ABSTRACT

**Background and Aims:** Prognostication of chest trauma patients by scoring systems is of vital importance to predict morbidity and mortality. We aimed to predict outcomes in chest trauma patients using chest trauma scoring system (CTS) in Indian patients. **Methods:** This was a prospective observational study done in a trauma care centre at a tertiary care teaching public hospital. CTS was calculated by scores of age, severity of pulmonary contusion, number of rib fractures and presence of bilateral rib fractures. Final CTS ranges from 2 to 12. We evaluated CTS to predict outcome that is mortality as primary objective and development of complications like pneumonia and need for ventilator support as secondary objective in Indian population. **Results:** Data were collected from 30 patients and they were divided into two groups, CTS <5 (15) and CTS ≥5 (15). High CTS ≥5 was statistically significantly associated with high incidence of pneumonia ( $P=0.046$ ), increased requirement of mechanical ventilation ( $P=0.025$ ) and mortality ( $P=0.035$ ) in chest trauma. Area under the ROC for mortality shows that the test is acceptable (0.75) and at CTS score 5.5 maximum sensitivity is 87.5% and specificity is 68%. **Conclusion:** This study concludes that a CTS ≥5 is associated with poor outcomes. This scoring system may be used to identify patients at risk of complications and institute early intensive focussed care.

**Key words:** Chest trauma score, mortality, thoracic trauma

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## INTRODUCTION

Trauma is the leading cause of death in India. Thoracic trauma is the third most common traumatic death, after head and spinal cord injury. The incidence of chest trauma is reported 10% of trauma admissions and mortality rate is variable ranging from about 10% to 60%.<sup>[1-5]</sup>

Trauma to thoracic region has a wide spectrum from chest wall injury to vital organs within the thoracic cavity. Thoracic injuries may be penetrating or blunt and management varies from conservative to invasive.<sup>[4]</sup> Though multiple studies have been done to evaluate factors that predict morbidity and mortality in thoracic trauma, few have developed into scoring systems. A prognostic scoring system makes it easier to manage by directing resources. Improved outcomes and decreased hospital stay was reported following score and protocol based interventions in

trauma victims.<sup>[6,7]</sup> The need for a universal system for thoracic trauma is justified to identify critical factors, to predict patient outcomes, urgent need for intervention, requirement of intensive care, and to communicate with the family.

There are global poly-trauma scales, like Injury Severity Score (ISS) or the Trauma Injury Severity Score (TRISS) which predict outcome in case of poly-trauma but in case of isolated thoracic trauma

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the score may not predict the outcome correctly.<sup>[8]</sup> The available thoracic trauma scores are Wagner score, Abbreviated Injury Scale chest (AIS), Lung Injury Scale, Pulmonary Contusion score (PCS), or RibScore, Thoracic Trauma Severity Score (TTSS) and modified early warning signs (MEWS) scoring system.<sup>[2,9-13]</sup> Due to difficult applicability of some scores, lack of significance for predicting outcome or resource limitation, there is no universal scoring system. Studies done on scoring systems for thoracic trauma recognise age, rib fractures, pulmonary contusions and bilateral injury as the most important factors affecting prognosis of chest trauma patients.<sup>[2,14,15]</sup> These factors individually or combined may help in predicting outcome. The Chest Trauma Score (CTS) was derived from number of above factors, devised by Pressley *et al.* and validated by Chen.<sup>[6,14]</sup> Chen *et al.* found that this simple score can predict the possibility of poor outcome like complications and mortality in thoracic trauma patients if CTS  $\geq 5$ . However, it was not studied on Indian patients. In developing nations in limited resource setting, national guidelines and a standard scoring system will bring uniformity in assessment and management of chest trauma patients. Therefore, we decided to study CTS in Indian subpopulation in a public hospital. We evaluated CTS to predict mortality as primary objective and development of complications like pneumonia and need for ventilator support as secondary objective.

## METHODS

The study was initiated after obtaining permission from the Institutional Ethics and Research Committee vide approval number ECARP/2015/190 dated 30<sup>th</sup> June 2014. Written informed valid consent was obtained from patient or relatives. Study was conducted in trauma care unit of tertiary care teaching public hospital, over a study period of 5 months from July 2014 to November 2014. The trauma care unit is a 15-bed intensive care unit managed by anaesthesiologists and surgeons with multispecialty involvement. This was a prospective observational study and data were collected from all the patients admitted to trauma care unit with chest trauma. We excluded patients under the age of 18 years and patients with significant injury to body parts other than chest.

We noted demographic parameters, history, vital parameters and necessary investigations including chest X-Ray and Computed Tomography (CT) chest when patient was admitted in trauma unit. Chest

trauma score was calculated as given in Table 1. The CTS is composed of four different components with a point system assigned: age (<45 years = 1, 45–65 = 2, >65 = 3); pulmonary contusion (none = 0, unilateral minor = 1, bilateral minor = 2, unilateral major = 3, bilateral major = 4); number of rib fracture (<3 = 1, 3-5 = 2, >5 = 3); and the presence of bilateral rib fracture = 2. Number of rib fractures and pulmonary contusion were noted from chest X-ray and Computed Tomography (CT). Each parameter has been assigned specific score and final score was calculated by adding scores of each parameter. Final CTS was then calculated which ranges from 2 to 12.

On the basis of final CTS, patients were divided into 2 groups with CTS <5 and  $\geq 5$ . Grouping was done based on article by Chen *et al.* as they found that CTS  $\geq 5$  can predict the possibility of poor outcome.<sup>[14]</sup>

Outcomes were defined as mortality or development of complications like pneumonia and need for ventilator support. Standard clinical and radiographic criteria were used for diagnosing pneumonia and initiation of ventilator support was based on the clinician's decision.

Patients were managed according to standard chest trauma management protocol of our institute. It included but not limited to intensive monitoring including blood gas analysis, optimum analgesia (oral/IV/epidural/regional), respiratory support and any required intervention. CTS calculation and management of the patient was done by attending trauma registrar. Study did not interfere with standard chest trauma management protocol of our institute.

The sample size was based on the prevalence rate in our institute and from past medical records. Sample size was determined by convenience sampling. It has been calculated to be 30 as the approximate admissions

Table 1: Calculation of chest trauma score

Age score	Score	Rib score	Score
<45 y	1	<3 RIBFX	1
45-65 y	2	3-5 RIBFX	2
>65 y	3	>5 RIBFX	3
<b>Pulmonary contusion score</b>		<b>Bilateral RIBFX</b>	
None	0	No	0
Unilateral minor	1	Yes	2
Bilateral minor	2		
Unilateral major	3		
Bilateral major	4		

(Final score 2-12, Patients grouped as <5 and  $\geq 5$ ). RIBFX – Rib fractures

with isolated chest trauma are 5-6 per month according to the trauma admission register.

The data were collected prospectively from patient and patient's record file at the time of admission to trauma unit of tertiary care hospital till the patient was transferred to ward or had died, by an observer who was not directly involved in the patient management. Chest trauma scores were calculated in all patients and appropriate statistical techniques were applied with respect to outcomes.

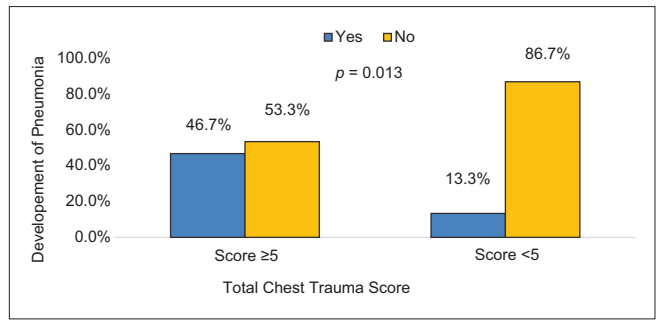
Quantitative data were presented with the help of Mean, Standard deviation (SD), Median and Interquartile range (IQR). Qualitative data were presented with frequency and percentage table. Association among various study parameters were assessed with the help of Chi-square test. *P* value <0.05 was taken as value of significance. Results were graphically represented where deemed necessary. Statistical analysis was performed with statistical package for social sciences Version 19 (SPSS Inc. for Mac, IBM Corporation Inc. Chicago, IL, USA) and MS Excel was used for data storage and graphs.

**RESULTS**

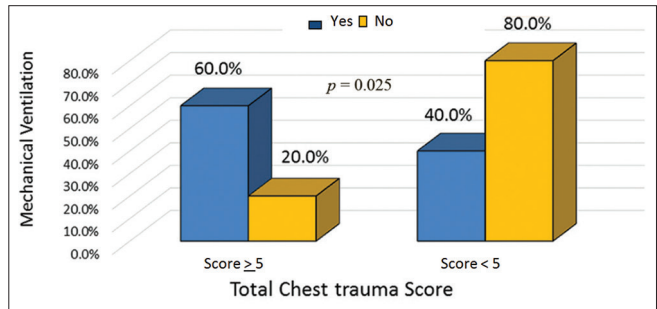
Out of 30 patients 23 (76.7%) patients were younger than 45 years, 5 (14.7%) were between 45 and 65 years and remaining 2 (6.7%) patients were older than 65 years. The mean ± SD age of the patients admitted with isolated chest trauma was 34.50 ± 15.861 years. Out of 30 patients 26 patients (86.7%) were males and 4 (13.3%) were females. Total CTS was calculated by adding scores of each parameter [Table 1]. The final CTS noted in this study were in the range of from 2 to 12 with mean score of 5 ± 1.250. On the basis of total CTS, patients were divided into Total chest trauma score <5 (15 patients) and ≥5 (15 patients).

Association between high CTS ≥5 and development of pneumonia was found to be statistically significant [Figure 1]. Association between high CTS ≥5 and requirement of mechanical ventilation was found to be statistically significant with a chi square coefficient of 5.000 and *P* value of 0.025 [Figure 2].

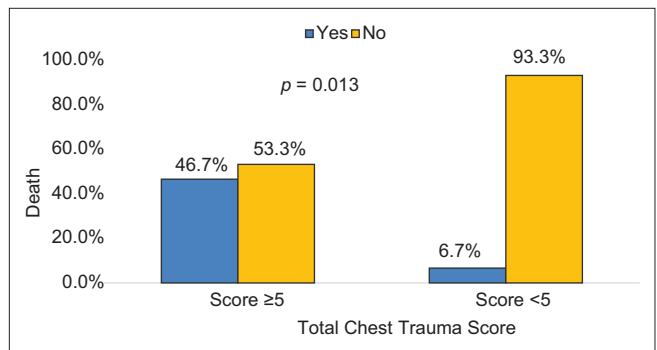
Total CTS ≥5 was significantly associated with mortality with a chi square coefficient of 6.136 and *P* value of 0.035, thus the association between high CTS and mortality was found to be statistically significant [Figure 3]. Mortality across different ranges of the CTS is displayed in Figure 4.



**Figure 1:** Association between Total Chest Trauma Score and Development of Pneumonia



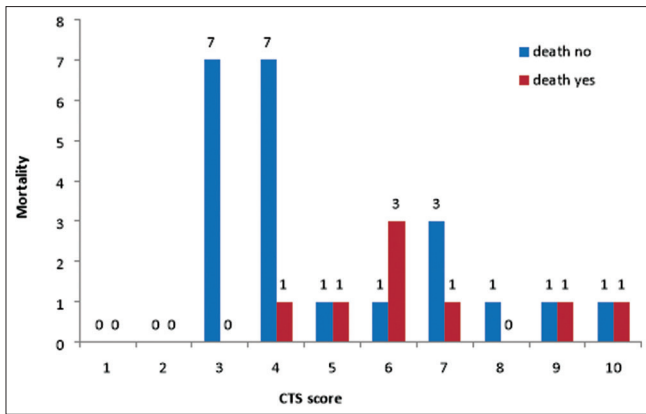
**Figure 2:** Association between total chest trauma score and mechanical ventilation



**Figure 3:** Association between Total Chest Trauma Score and Mortality

We also analysed each score component separately with respect to association with outcome. All the patients ≥45 years in the study group (7) required mechanical ventilation (chi square coefficient of 13.696 and a *P* value = 0.000). Patients' ≥45 years had 71.4% mortality as compared to 13% in <45 years. With a chi square coefficient of 9.355 and a *P* value of 0.007, the association between increasing age and mortality was found to be statistically significant. However, association between increasing age and pneumonia was not statistically significant (*P* = 0.640).

Development of pneumonia, requirement of mechanical ventilation and mortality were associated with increasing number of Rib fractures (>3), high



**Figure 4:** Mortality across different ranges of the Chest Trauma Score (CTS)

pulmonary contusion and bilateral injury individually but they were statistically not significant ( $P > 0.05$ ).

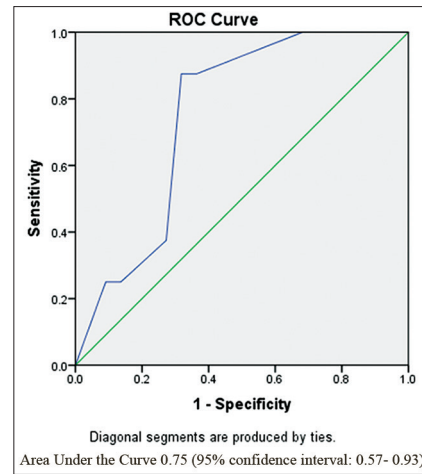
Area under the receiver operating characteristic curve (ROC) for mortality is shown in Figure 5. The test is acceptable with significant area under curve of 0.75. At CTS score 5.5 maximum sensitivity is 87.5% and specificity is 68%.

## DISCUSSION

The CTS was evaluated with respect to outcome in 30 patients admitted with chest trauma over the specified study period, at a trauma care unit of a tertiary care teaching public hospital.

Immediate and precise assessment of the severity level in thoracic trauma is essential for prompt and correct management, for predicting outcome, complications and requirement of intensive care and also explain prognosis to patients and relatives. If the assessment of the chest trauma severity is consistent and uniform based on standard scoring system, classification and triage can be done quickly and implementation of treatment protocols will be prompt in the emergency room. Joshipura *et al.* mentioned the lack of organised trauma care and gross disparity between trauma services available in various parts of India.<sup>[16]</sup> A simple universal scoring system like CTS to assess both the severity of the trauma and for prognostication may help to standardise trauma care in India.

In the present study CTS the final CTS noted was in the range from 2 to 12 with mean score of  $5 \pm 1.250$ . Severe chest injury with high CTS hinders with deep breathing and coughing out of secretions, leading to secondary respiratory complications, development of



**Figure 5:** Area under the receiver operating characteristic curve (ROC) for mortality

pneumonia and requirement of mechanical ventilation. This was proved in our study as high CTS  $\geq 5$  was significantly associated with high incidence of pneumonia ( $P = 0.046$ ) and increased requirement of mechanical ventilation ( $P = 0.025$ ) in chest trauma. In a study by Pressley *et al.* high CTS scores were associated with pulmonary complications and are more likely to require intubation.<sup>[14]</sup> Chen *et al.* showed that patients with CTS  $\geq 5$  had a greater prevalence of pneumonia and mechanical ventilation.<sup>[6]</sup>

In the current study high total CTS was also significantly associated with mortality ( $P = 0.035$ ). Early mortality was seen in bilateral multiple internal injuries with major vessel and refractory respiratory failure was the commonest cause for late mortality. Studies by both Pressley *et al.* and Chen *et al.* show that high CTS scores have a greater prevalence of mortality.<sup>[6,14]</sup> Chen further stresses that CTS  $\geq 5$  is an important independent predictor for all three outcomes separately that is mortality, pneumonia, and Acute Respiratory Failure.<sup>[6]</sup> Chen *et al.* also compared CTS with ISS and AIS chest and they were found to be insignificant for predicting all three outcomes in the same patients.<sup>[6]</sup>

This scoring system may assist in the triage, resource utilisation like ICU bed and ventilator. Also in patients with high CTS on admission, earlier implementation of treatment strategies such as but not limited to epidural analgesia, supportive ventilation, and intercostal drainage (ICD) can be applied to reduce morbidity and mortality.<sup>[2,9,17]</sup>

Each score component was also analysed separately for association with outcome in the current study.

The association of increasing age with requirement of mechanical ventilation ( $P = 0.640$ ) and mortality ( $P = 0.007$ ) was significant but with pneumonia was not statistically significant. Battle *et al.* also showed increased odds of mechanical ventilation with increase in age.<sup>[18]</sup> Bulger *et al.* also showed increased number of ventilator days with elderly suffering with blunt chest trauma.<sup>[19]</sup> Stitzel *et al.* suggested a threshold of 55 years as a factor that increased the risk of mortality in patients with chest trauma.<sup>[20]</sup> Our findings are very similar. Hence, elderly must be given early ICU care during management of chest trauma.

Development of pneumonia, requirement of mechanical ventilation and mortality were associated with increasing number of rib fractures (RIBFX >3), high pulmonary contusion and bilateral injury individually but they were statistically not significant. This suggests that these components as an individual parameter may not be suitable to predict outcomes but when used together as a total score may help to predict outcome. Thus, this CTS system may give better predictive value of outcome than individual parameter.

Battle CE mentions in their meta-analysis on risk factors that predict mortality in patients with blunt chest wall trauma that patient age of 65 years or more, three or more rib fractures, the presence of cardiopulmonary disease, development of pneumonia post injury were significant risk factors for mortality.<sup>[18]</sup> Many similar studies done in this regard have mentioned elderly, pre-existing co-morbidities, rib fractures, flail chest, bilateral chest injury, lung parenchyma injury, multiorgan involvement as most important factors associated with poor outcomes.<sup>[4,9,15,21,22]</sup> Also studies have mentioned that Scoring systems help to identify the high risk patients requiring intensive focused management and will help improve patient outcomes.<sup>[3,15,23]</sup> CTS include most of the factors mentioned above.

Area under the ROC for mortality shows that the test is acceptable with significant area under curve of 0.75. The score is sensitive to predict outcome as at CTS score 5.5, maximum sensitivity is 87.5% and specificity is 68%. Thoracic trauma severity score (TTSS) is another popular chest trauma score which combines anatomical and physiologic parameters have been also found most suitable for severity assessment and prediction of outcome in blunt chest trauma.<sup>[1,7,23]</sup> Studies have mentioned that TTSS has a

high correlation with the occurrence of complications or mortality in patients with thoracic trauma; however applicability in Indian low resource setting should be checked as availability of blood gas analysis may be considered as limitation. However, we did not compare both the scores in this study. Ekpe EE studied a modified early warning signs (MEWS) scoring system to prognosticate outcome in chest trauma and it correlated positively with mortality.<sup>[2]</sup> Applicability in Indian population needs further studies.

Failure to treat blunt chest injuries in a timely manner with adequate analgesia, physiotherapy and respiratory support, often results in complications leading to pneumonia, respiratory failure and death.<sup>[17]</sup> In an integrative review Kourouchea *et al.* suggests that respiratory intervention, multi-modal analgesia, complication prevention and surgical fixation are early interventions that improved Blunt Chest trauma outcomes.<sup>[24]</sup> Early institution of these chest care bundle would be possible after categorising chest trauma patients on the basis of standard scoring system like CTS and multi-disciplinary involvement at the earliest. CTS can be applied quickly in the emergency room and appropriate intervention can be instituted without delay.

CTS thus have given promising results in predicting outcomes in chest trauma and can be useful in Indian subpopulation. However, unavailability of CT scan in peripheral rural areas may limit its use. Although CT is considered most sensitive for diagnosing pulmonary contusion, chest radiography may also be used in its place to grade pulmonary contusion in low resource settings and thus CTS may be used.<sup>[11,25]</sup>

Our study has its share of limitations. Present study had a small sample size and was conducted at a single tertiary care teaching public institution. A multi centric comparative study would have given us a better sample size and perhaps more validation and shall be done in the future.

## CONCLUSION

Thus, from the present study we conclude that CTS is a good predictor of outcome in chest trauma patients. High chest trauma score (CTS  $\geq 5$ ) is associated with mortality and with development of pneumonia and requirement of mechanical ventilation. This scoring system may be used to identify patients at risk of complications and institute early intensive focussed care.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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