Annals of Medicine and Medical Sciences (AMMS)
Volume 05, 2026, *Page No.: 181 to 186*
Available at: *http://ammspub.com*

Original Article

OPEN ACCESS

To Study Prediction of Outcome of Chest Trauma Using Chest Trauma Scoring System at Tertiary Care Centre

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Abstract

Background: Aim of this study is to investigate CTS-based prognostic and predictive outcomes in individuals with chest injuries following chest trauma. ***Methods:*** This prospective observational study conducted at a tertiary care center in India involved 70 patients with thoracic trauma. Upon admission to the emergency department or trauma unit, a comprehensive clinical evaluation was carried out, which included a detailed history, vital signs, and necessary investigations such as chest radiographs and computed tomography (CT) or high-resolution CT (HRCT) of the chest, provided the patient's hemodynamics were stable. The study utilized four key factors age, pulmonary contusion identified via HRCT, the total number of rib fractures, and the presence of bilateral rib fractures to calculate the chest trauma score. ***Results:*** Seventy cases were analyzed, revealing 50 survivors and 20 non-survivors. Survivors had an average age of 45.52 years, compared to 35.45 years for non-survivors. The gender ratio was 60% male among survivors and 70% among non-survivors. Notable physiological factors for non-survivors included higher pulse rates (130.66 bpm vs. 113.48 bpm), lower blood pressures (SBP 93.33 mmHg, DBP 59 mmHg), and increased respiratory rates (29/min vs. 23.86/min). Key mortality predictors were chest symmetry, subcutaneous emphysema, and a need for intubation, with 75% of non-survivors requiring airway intervention. Pneumonia was present in 75% of non-survivors. A correlation between GCS scores showed survivors averaged 15.60 compared to 12.20 for non-survivors. Bilateral fractures linked to higher pain and reduced quality of life, whereas fewer or unilateral fractures supported recovery. ***Conclusion:*** The chest trauma scoring system effectively predicts outcomes in thoracic injury patients, correlating higher scores with increased severity, intervention needs, and mortality rates. Key clinical parameters, including vital signs and complications like pneumonia, improve its predictive accuracy, enabling early identification of high-risk patients and facilitating timely management for better outcomes.

Keywords: ***Chest Trauma, Thoracic trauma, Rib fractures, Traffic accidents, Glasgow Coma Scale.***

Introduction

In India, trauma is the leading cause of death, with thoracic trauma ranking as the third leading cause of traumatic fatalities following brain and spinal cord injuries. It occurs in 10% of trauma admissions, and the mortality rate ranges from 10% to 60% [1,2]. Nearly 90% of trauma-related deaths happen in low- and middle-income countries, with thoracic trauma comprising 6% of traffic accidents. This issue is exacerbated by modern high-speed vehicles and insufficient traffic law enforcement. Limited studies exist on the treatment and extent of this form of trauma in India, while in developed countries, trauma is the third leading cause of death after heart disease and cancer [3,4].

Treatment of thoracic trauma is critical due to its potential life-threatening nature. Advances in treatment, including the use of arterial blood gas analysis (ABG), X-rays, blood transfusions, ventilators, antibiotics, ultrasound, and advanced imaging techniques like multislice computed tomography have significantly improved outcomes. Interventional methods such as tube thoracostomies and bronchoscopy are also pivotal [5,6]. Thoracic injuries are categorized primarily into blunt and penetrating injuries, with blunt trauma often resulting from traffic accidents and penetrating trauma typically arising from gunshot or stab wounds [7,8]. Clinical features can be subtle in blunt injuries, whereas penetrating injuries tend to have more pronounced features.

Thoracic injuries can vary in severity and are treated from observation to surgery. Few studies have established scoring systems to assess and predict outcomes, aiding in resource allocation and treatment planning. These systems improve patient outcomes and reduce hospital stays. Standardization is essential to identify crucial

Received: December 05, 2025; **Revised:** January 12, 2026; **Accepted:** February 02, 2026

variables for predicting outcomes, triaging patients, determining care intensity, and family communication [4,8-10].

The Chest Trauma Score (CTS), created by Pressley *et al*. and reviewed by Chen, considers variables like age, rib fractures, pulmonary contusions, and bilateral injuries to assess chest injury prognosis. A CTS score of 5 suggests severe risk for patients. Current research on trauma in the Indian population is insufficient, highlighting the need for a standardized scoring system to improve assessment and treatment of thoracic trauma in resource-limited settings [11]. This study examines the prognostic and predictive outcomes of thoracic trauma using the thoracic trauma scale (CTS) in a subpopulation at the Indian Nepal Border. The primary focus is on predicting mortality, while secondary outcomes include assessing comorbidities like pneumonia and the necessity for ventilatory support.

Methods

This was a prospective observational study conducted in Department of General Surgery, ASMC, Bahraich over a period of one year. Total 70 patients diagnosed with thoracic trauma were enrolled in this prospective observational study based on well-defined inclusion and exclusion criteria. Study was approved by the institutional ethics committee. Written informed consent was obtained from each patient. All patients over 16 years diagnosed with chest trauma were included in the study, while those under 16, with other injuries, unable to undergo necessary radiological examinations, or with concomitant diseases such as COPD were excluded.

A comprehensive evaluation is conducted upon patient admission to the emergency department, including a history, vital signs, clinical assessment, and needed imaging such as chest radiography or CT scans if hemodynamics are stable. A chest trauma score is calculated based on age, pulmonary contusion, the number of rib fractures, and whether bilateral rib fractures are present. The CTS is composed of four different components, each of which is assigned a point

Age

- < 45 years =1 point,
- 45-65 years =2 points,
- 65 years =3 points

Pulmonary contusion

- none=0,
- unilateral minor=1 point, (1 lobe unilateral)
- bilateral minor=2 points, (1 lobe bilateral)
- unilateral major=3 points, (2 lobes bilaterally)
- bilateral major=4 points (> 2 lobes bilateral)

Number of rib fractures

- <3 ribs =1 point,
- 3-5 ribs =2 points,
- 5 ribs =3 points
- Presence of bilateral rib fractures =2 points.

The assessment of rib fractures and pulmonary contusions was conducted using chest radiographs and high-resolution computed tomography (HRCT), with each parameter receiving a specific score that contributed to a final cumulative score.

Statistical analysis

SPSS version 22nd was employed for analysis. Data were articulated as mean along with standard deviation, and additionally represented as percentages. To compare categorical variables, the Chi-square test was utilized, while the independent t-test was applied for comparing discrete variables across different groups. A p-value of 0.05 was established as the threshold for statistical significance.

Results

Total of 70 cases were analyzed, comprising 50 in the survivor group and 20 in the non-survivor group. The mean age for survivors was 45.52±11.70 years, while for non-survivors it was 35.45±4.65 years. Gender distribution showed that the survivor group consisted of 60.0% males and 40.0% females, compared to 70.0% males and 30.0% females in the non-survivor group. Despite similar age and gender distributions, significant differences in physiological parameters were evident. Non-survivors had a higher mean pulse rate of 130.66 bpm vs. 113.48 bpm in survivors (p=0.007). Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were significantly lower in non-survivors (SBP 93.33 mmHg; DBP 59 mmHg) compared to survivors (p<0.001 and p=0.001, respectively), indicating greater shock or circulatory challenges. Respiratory rates were also elevated in non-survivors at 29/min compared to 23.86/min in survivors (p=0.007). Overall, vital sign abnormalities such as tachycardia, hypotension, and tachypnea were strong indicators of poor prognosis, while demographic factors did not affect survival outcomes (**Table 1**).

The analysis of clinical parameters between survivors and non-survivors identified key mortality predictors. Significant associations included chest symmetry (p=0.022), with non-survivors exhibiting more bilateral asymmetry, indicating severe thoracic injury. Subcutaneous emphysema was linked to mortality (p=0.043), particularly bilateral cases, suggesting severe chest trauma. Intubation was highly significant (p<0.001), as 75% of non-survivors needed airway intervention, reflecting respiratory failure. Pneumonia also correlated with mortality (p<0.001), present in 75% of non-survivors, worsening pulmonary status. Other factors like mode of injury and chest movement showed no significant links, but non-survivors had more severe rib fractures (>5 ribs). Overall, the severity of chest injury and respiratory complications were critical for survival in this cohort (**Table 2**).

Comparison of Glasgow Coma Scale (GCS) scores reveals a significant link between neurological status at presentation and survival outcomes. Survivors exhibited a mean GCS of 15.60±1.30, indicating full consciousness, while non-survivors had a mean GCS of 12.20±1.20, reflecting impaired consciousness. The statistical difference ($t = 4.5$, $p = 0.006$) signifies that reduced GCS correlates with higher mortality risk. A lower GCS often indicates severe trauma and related complications affecting prognosis. These results emphasize the necessity of early neurological assessment in trauma patients, with GCS serving as a crucial predictor of clinical outcomes, particularly highlighting that lower GCS scores correlate with a greater likelihood of non-survival (**Table 3**).

The assessment of quality of life using the Visual Analog Scale (VAS) after two months indicates significant variation in pain outcomes based on rib fracture characteristics. Patients with bilateral rib fractures (n=45) reported moderate pain (VAS scores 4-6), suffering prolonged discomfort and slower recovery. Conversely, patients with more than five rib fractures (n=30) experienced lower pain scores (1-3), suggesting better pain control or healing. Unilateral rib fracture patients (n=44) reported mild pain (VAS 1-3), indicating a better quality of life. In summary, bilateral fractures correlate with higher residual pain and lower quality of life, while fewer or unilateral fractures allow for more comfortable recovery (**Table 4**).

Table 1: Demographic characteristics of the patients in between survivor and non-survivor groups

	Survivor (n=50)		Non-survivor (n=20)		t	p-Value
	Mean	±SD	Mean	±SD		
Age (in years)	45.52	11.70	35.45	4.65	1.58	0.88
Gender	No.	%	No	%		
Male	30	60.0	14	70.0	0.19	0.660
Female	20	40.0	6	30.0		
Pulse Rate (beats/min)	113.48	15.77	130.66	19.75	-2.80	0.007*
SBP (mmHg)	115.68	12.72	93.33	4.84	4.23	<0.001*
DBP (mmHg)	78.59	6.8	59.00	9.20	2.66	0.001*
Respiratory Rate (/min)	23.86	2.67	29.00	1.67	-4.56	0.007*

Table 2: Comparative analysis of various clinical factors related to chest injuries, including injury mode frequency, chest symmetry, chest movement, skin condition over the chest wall, trachea positioning, air entry, rib fractures (both bilateral and total), ICD insertion, subcutaneous emphysema, and intubation rates in survivor versus non-survivor groups.

		Survivor (n=50)		Non-survivor (n=20)		Total	Chi Sq.	p-Value
		n	%	n	%	n		
Mode of injury	Animal hit	5	10.0	0	0.00	3	3.20	0.13
	Assault	15	30.0	0	0.00	14		
	RTA	30	60.0	6	100.00	33		
Symmetry of chest	Left sided asymmetrical	12	24.0	8	40.0	20	12.01	0.022
	Tight sided asymmetrical	12	24.0	0	0.00	12		
	B/L asymmetrical	8	16.0	12	60.0	20		
	Symmetrical	18	36.0	0	0.00	18		
Chest Movement	Left sided decreased	20	40.0	10	50.00	30	2.57	0.277
	Right sided decreased	15	30.0	10	50.00	25		
	Equal	15	30.0	0	0.00	15		
Skin over chest wall	Abrasion	35	70.0	20	100.00	55	1.92	0.589
	Bruises present	5	10.0	0	0.00	5		
	Laceration	5	10.0	0	0.00	5		
	No	5	10.0	0	0.00	5		
Subcutaneous Emphysema	Lt sided present	15	30.0	8	40.0	23	4.18	0.043*
	Rt sided present	15	30.0	0	0.00	15		
	B/L present	10	20.0	12	60.0	22		
	Absent	10	20.0	0	0.00	10		
Position of trachea	LT Sided deviation	5	10.0	2	10.0	7	1.72	0.423
	Midline	40	80.0	18	90.0	58		
	RT sided deviation	5	10.0	0	0.00	5		
Bilateral air entry	Left decreased	5	10.0	0	0.00	5	3.22	0.450
	Right decreased	5	10.0	0	0.00	5		
	B/L Equal	20	40.0	0	0.00	20		
	B/L Decreased (Rt>lt)	15	30.0	10	50.00	25		
	B/L Decreased (Lt>Rt)	5	10.0	10	50.00	15		
Rib Fractures	Present	50	100.00	20	100.00	70	-	-
	Absent	0	0.00	0	0.00	0		
Bilateral Rib Fracture	Present	30	60.0	20	100.00	50	1.58	0.25
	Absent	20	40.0	0	0.00	20		
No. of Rib Fracture	≤5	30	60.0	0	0.00	30	5.55	0.065
	>5	20	40.0	20	100.00	40		
ICD Insertion	Left decreased	5	10.0	5	25.0	10	2.22	0.25
	Right decreased	5	10.0	5	25.0	10		
	B/L Equal	20	40.0	0	0.00	20		
	B/L Decreased (Rt>lt)	20	40.0	10	50.0	30		
Intubation	Done	5	10.0	15	75.0	20	24.4	<0.001
	Not done	40	80.0	0	0.00	40		
	NA	5	10.0	5	25.0	10		
Pneumonia	Yes	5	10.0	15	75.0	20	26.05	<0.001
	No	45	90.0	5	25.0	50		

Table 3: Mean GCS of patients between survivor and non-survivor groups

	Survivor (n=50)		Non-survivor (n=20)		t	p-Value
	Mean	±SD	Mean	±SD		
GCS	15.60	1.30	12.20	1.20	4.5	0.006*

Table 4: Quality of life in study population

		VAS score after 2 month
Patients with Bilateral Rib Fracture (n=45)	Pain	4-6
Patients with >5 rib fracture (n=30)	Pain	1-3
Patients with rib fracture (n=44)	Pain	1-3

Discussion

In India, thoracic trauma is a significant cause of mortality, ranking third after brain and spinal cord injuries. Approximately 10% of hospitalizations involve thoracic trauma, with mortality rates ranging from 10% to 60%. Treatment options vary from conservative to invasive, and include both stabbing and blunt injuries. Numerous studies have explored scoring systems for predicting outcomes, but no single scoring system is universally applicable due to limitations in resources and validity. In a study of 50 patients, the death rate from chest trauma was 12%, aligning with findings that mortality from blunt thoracic injuries can range from 4% to 60% [12]. The overall associated mortality rate for thoracic trauma is estimated at about 10% [13].

Total of 70 cases analyzed revealed 50 survivors and 20 non-survivors. Mean age for survivors was 45.52 years, while non-survivors averaged 35.45 years. The survivor group had 60% males and 40% females, contrasted with 70% males and 30% females in the non-survivor group. Significant physiological differences included higher pulse rates in non-survivors (130.66 bpm) versus survivors (113.48 bpm), lower blood pressure in non-survivors (SBP 93.33 mmHg; DBP 59 mmHg), and elevated respiratory rates (29/min for non-survivors compared to 23.86/min for survivors). Vital sign abnormalities like tachycardia, hypotension, and tachypnea were strong indicators of poor prognosis, while demographics did not influence survival outcomes. Initial evaluation of trauma patients should assess vital signs, including blood pressure, as these factors influence mortality. Studies indicate that 20% of patients with normal blood pressure and heart rate die, compared to 36% with abnormal values. Particularly high mortality rates are found among those with hypotension and bradycardia (80%), hypertension and bradycardia (58%), and hypotension with tachycardia (48%). Both hypotension and hypertension correlate with increased mortality, with a notable rise in short-term mortality following a 10 mmHg decrease in systolic blood pressure, heightening death risk by 4.8%. A systolic blood pressure below 110 mmHg significantly elevates mortality rates, while hypotension is often a late finding due to compromised physiological responses. Blood pressure metrics serve as predictive indicators for trauma-related injuries [14-18].

The analysis of clinical parameters between survivors and non-survivors identified key mortality predictors. Significant associations included chest symmetry (p=0.022), with non-survivors exhibiting more bilateral asymmetry, indicating severe thoracic injury. Subcutaneous emphysema was linked to mortality (p=0.043), particularly bilateral cases, suggesting severe chest trauma. Intubation was highly significant (p<0.001), as 75% of non-survivors needed airway intervention, reflecting respiratory failure. Pneumonia also correlated with mortality (p<0.001), present in 75% of non-survivors, worsening pulmonary status. Other factors like mode of injury and chest movement showed no significant links, but non-survivors had more severe rib fractures (>5 ribs). Overall, the severity of chest injury and respiratory complications were critical for survival in this cohort. In this study, chest trauma incidence was highest in road traffic accidents (60%), followed by assaults (30%) and animal attacks (10%). Mortality rates were notably high in RTAs without significant differences. RTAs also present with thoracic injuries in about 50% of cases, frequently accompanied by multiple traumas [19,20]. Blunt chest injuries were commonly caused by road traffic accidents (RTAs) (69.4%), falls from height (14.9%), and assaults (11.1%) in the study by Shukla *et al*. RTAs have risen due to urbanization, industrialization, and lax regulations. Jain *et al*. state that RTAs account for 56% of trauma cases, with males being the most affected demographic, differing by age and gender [13,21,22].

Asymmetric and subcutaneous bilateral emphysema are strongly linked to mortality in patients with thoracic injuries, contributing to 25% of trauma-related deaths, many of which are preventable. Subcutaneous emphysema, common in chest trauma patients, indicates respiratory system injury and serves as a clinical predictor for occult pneumothorax, with an odds ratio of 5.47. Furthermore, airway injuries, such as pneumothorax and hemothorax, can result in hemodynamic instability and respiratory failure [23,24].

In this study, rib fractures were consistently observed in all patients, especially in mortality groups where all had bilateral rib fractures and over five fractures were noted among deceased individuals. Increased morbidity and mortality rates correlate with the number of fractured ribs, underscoring the need to hospitalize patients with three or more isolated rib fractures and to treat elderly patients with six or more fractures in intensive care. Mortality rate post-fracture begins at 10% and escalates to 40% with more than six fractures. Additional studies indicate that organ damage, length of hospital stay, and overall severity of chest injuries are all positively correlated with the number of fractured ribs, especially in cases of hemothorax and pneumothorax [25,26].

In this study, intubation was notably more frequent in the mortality group than in the survival group. Shukla *et al*. reported that out of 134 patients needing intubation in the ICU, 39 had polytrauma with an injury severity score exceeding 15, indicating an increased risk of ICU admission and intubation [13].

Comparison of Glasgow Coma Scale (GCS) scores indicates a significant relationship between neurological status and survival outcomes. Survivors had a mean GCS of 15.60±1.30, signifying full consciousness, while non-survivors averaged 12.20±1.20, indicating impaired consciousness. The statistical difference ($t = 4.5$, $p = 0.006$) shows that lower GCS scores correlate with higher mortality risk, emphasizing the importance of early neurological assessments in trauma patients, as lower GCS scores predict increased likelihood of non-survival. The GCS score differs significantly between survivors (14.71±1.509) and nonsurvivors (7.05±4.576). Matis and Birbilis report survivor scores of 6.81, while non-survivors average 5.55,

suggesting that the focus of Carson *et al*. on head injuries may account for higher scores among survivors in this study [27].

The study recommends the routine use of a chest trauma scoring system for early risk stratification in chest trauma patients, particularly in busy emergency and trauma centers. Emphasis is placed on training healthcare providers to assess vital signs, GCS, chest findings, and complications accurately, which would enhance predictive accuracy. Integrating this scoring system into triage protocols can facilitate timely referrals and optimize resource allocation. However, the study's limitations include a small sample size, a single-centre design, unaddressed confounders, and a short follow-up period, potentially affecting the findings' external validity.

Conclusion

The chest trauma scoring system is an effective tool for predicting outcomes in patients with thoracic injuries, showing a strong correlation between higher scores and increased injury severity, intervention needs, and mortality rates. Clinical parameters such as vital signs, GCS, and complications like pneumonia enhance the system's predictive accuracy. It allows for early identification of high-risk patients, leading to timely management and improved outcomes, making it a reliable method for risk stratification and treatment guidance in chest trauma cases.

Declarations

Ethics approval and consent to participate

Ethical approval was issued by Bauchi State Ministry of health.

Data Availability

Data available on corresponding author upon responsible request

Authors' Contributorship

All author contributor equally.

Conflict of Interest

None

Funding Statement

None

Acknowledgments

Not Applicable

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