Frontiers in Health Informatics
ISSN-Online: 2676-7104
www.healthinformaticsjournal.com
2026; Vol 15: Issue 1
Open Access

Profile and Outcome of Trauma Patients Requiring Mechanical Ventilation in SICU: A Single-Centre Study with RETRASCORE-Based Mortality Analysis

Dr. Fenil Zariwala[1]*, Dr. Lisha Suraj[2]

[1] Junior Resident (3rd Year), Department of General Surgery, MGM Medical College and Hospital, Kamothe, Navi Mumbai, Maharashtra, India

[2] Professor and Head, Department of General Surgery, MGM Medical College and Hospital, Kamothe, Navi Mumbai, Maharashtra, India

Corresponding Author:

Dr. Fenil Zariwala

Department of General Surgery, MGM Medical College and Hospital, Kamothe, Navi Mumbai – 410209, Maharashtra, India, Email: zariwalasomu@gmail.com

Cite this paper as: Dr. Fenil Zariwala, Dr. Lisha Suraj (2026) Profile and Outcome of Trauma Patients Requiring Mechanical Ventilation in SICU: A Single-Centre Study with RETRASCORE-Based Mortality Analysis. *Frontiers in Health Informatics, 15* (1), 8-21

Abstract

Background: Trauma patients requiring mechanical ventilation represent a high-risk population with significant morbidity and mortality. Early identification of clinical predictors and outcome determinants is crucial for improving survival in Surgical Intensive Care Units (SICUs). This study assessed the clinical profile, RETRASCORE parameters, ventilatory characteristics, and outcomes of trauma patients requiring invasive mechanical ventilation in a tertiary-care SICU.

Methods: This single-centre observational study included 50 trauma patients admitted to the SICU who required mechanical ventilation for ≥12 hours. Patient data were collected from SICU records and trauma register data. Demographics, injury patterns, physiological parameters, ventilatory details, complications, and RETRASCORE components were evaluated. RETRASCORE values were calculated retrospectively and correlated with outcomes..

Results: Males comprised 76% of the cohort, with road traffic accidents being the predominant mechanism of injury (70%). Head injury (60%) and chest trauma (38%) were the most common trauma patterns. The mean GCS on admission was 9.2 ± 3.4, and the mean PaO_2/FiO_2 ratio was 212 ± 68. The average duration of mechanical ventilation was 6.8 days, with ventilator-associated pneumonia occurring in 18%. Tracheostomy was required in 20% of patients, and re-intubation in 10%. The overall ICU mortality rate was 30%, significantly associated with severe neurotrauma, low GCS, hypoxemia, and higher RETRASCORE values.

Conclusion: Trauma patients requiring mechanical ventilation exhibit substantial severity and a notable mortality burden. RETRASCORE demonstrated strong predictive value for adverse outcomes. Early recognition of high-risk indicators and optimization of ventilatory strategies may improve patient survival.

Keywords: Trauma, Mechanical Ventilation, SICU, RETRASCORE, Clinical Outcomes

1. Introduction

Trauma continues to pose a major global public health burden, contributing substantially to morbidity, mortality, and long-term disability, particularly in low- and middle-income countries such as India, where rapid urbanization, industrialization, and increased vehicular density have led to a steep rise in high-impact injuries [1]. According to global estimates, trauma accounts for nearly 10% of all deaths annually, making it one of the leading causes of premature mortality, especially among individuals under 40 years of age [2]. Road traffic accidents (RTAs) constitute the largest proportion of traumatic injuries in India, followed by falls, assaults, and occupational hazards, frequently resulting in polytrauma, severe head injuries, thoraco-abdominal trauma, and long-bone fractures that often necessitate emergency resuscitation and ventilatory support [3]. Patients presenting with major trauma commonly require admission to intensive care units (ICUs), where close physiological monitoring, mechanical ventilation, and multi-organ support are essential to improving survival outcomes [4]. Mechanical ventilation remains a cornerstone in the management of severe trauma, particularly in cases of reduced Glasgow Coma Scale (GCS), extensive chest injuries leading to respiratory failure, and multi-system involvement that compromises airway protection or gas exchange [5]. However, the need for prolonged ventilatory support is associated with complications such as ventilator-associated pneumonia (VAP), barotrauma, sepsis, and prolonged ICU stay, all of which significantly increase mortality risk [6]. These challenges highlight the importance of reliable prognostic scoring systems to assist clinicians in early risk stratification, resource allocation, and treatment planning in busy trauma ICUs, especially in resource-limited environments [7]. Several scoring tools have been developed for trauma severity assessment, including the Injury Severity Score (ISS), Revised Trauma Score (RTS), Trauma and Injury Severity Score (TRISS), and APACHE II, but their applicability varies across settings, and some fail to accurately predict outcomes in mechanically ventilated trauma patients [8]. In this context, the RETRASCORE—developed from the Spanish ICU trauma registry (RETRAUCI)—has emerged as a specialized mortality prediction model validated specifically for trauma patients receiving critical care interventions, including mechanical ventilation [9]. The RETRASCORE incorporates clinical parameters such as physiological derangements, organ dysfunction indicators, injury patterns, and early ICU interventions, providing a robust and trauma-focused prognostic tool that demonstrates strong discriminatory ability in predicting ICU mortality [10]. Despite its proven reliability in European populations, limited data exist regarding its utility in diverse healthcare settings like India, where trauma epidemiology, prehospital delays, resource availability, and injury patterns differ markedly from Western countries [11]. Indian trauma patients often present late, with inadequate prehospital stabilization, contributing to worse physiological profiles on ICU admission and potentially influencing scoring accuracy [12]. Thus, evaluating the external validity of the RETRASCORE in an Indian surgical ICU (SICU) population is crucial for determining its feasibility and relevance in predicting mortality outcomes among mechanically ventilated trauma patients. Moreover, understanding demographic factors, mechanisms of injury, indications for mechanical ventilation, and associated complications can further enhance trauma triage and optimize ICU care pathways. Given the scarcity of Indian studies evaluating trauma-specific ICU prognostic models, the present study aims to fill this knowledge gap by analyzing the clinical profile, ventilatory requirements, and mortality predictors of trauma patients requiring mechanical ventilation in a single-centre SICU while applying the RETRASCORE retrospectively. Establishing the performance of the RETRASCORE in this context may support its integration into routine clinical decision-making, help guide resource utilization, and provide a foundation for developing multicentre validation studies within the Indian healthcare landscape.

2. Methods

2.1 StudyDesign

The study was conducted as a retrospective observational analysis.

2.2 StudySetting:

The study was carried out in the Surgical Intensive Care Unit (SICU) of MGM Hospital, Kamothe, a tertiary-care teaching institution equipped with advanced trauma care facilities.

2.3 StudyDuration:

The study was conducted over a clearly defined period, during which all eligible trauma patients requiring mechanical ventilation were included.

2.4 Participants – Inclusion and Exclusion Criteria:

Inclusion Criteria:

- Trauma patients of all age groups admitted to the SICU.
- Patients who required invasive mechanical ventilation at any point during SICU stay.
- Patients whose medical records were complete with documented clinical, radiological, and laboratory data.
- Patients for whom all RETRASCORE parameters could be applied retrospectively.

Exclusion Criteria:

- Patients who died or were transferred out before initiation of mechanical ventilation.
- Patients with incomplete or missing SICU records.
- Non-trauma patients admitted for postoperative or medical causes.
- Patients ventilated only for procedural sedation or short-term elective indications.

2.5 Study Sampling:

A total enumeration sampling technique was employed, meaning all eligible trauma patients meeting the inclusion criteria during the study period were included. Since the study aimed to capture the full spectrum of ventilated trauma cases, this sampling strategy minimized selection bias and allowed comprehensive analysis of demographic patterns, injury characteristics, and outcomes. No randomization or subgroup allocation was performed, as the study's retrospective nature focused on data extraction from available records.

2.6 Study Sample Size

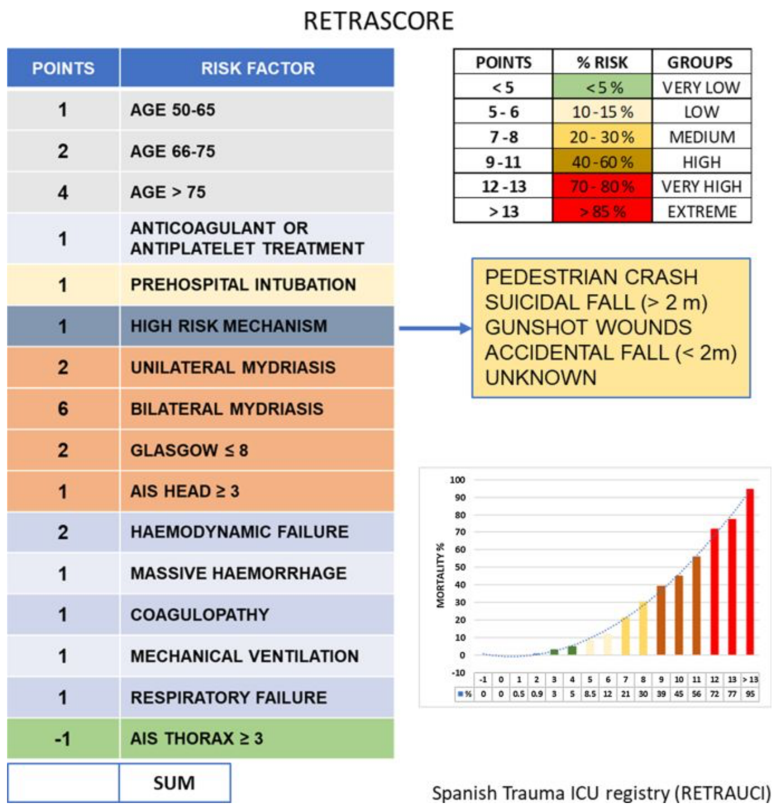
The final sample comprised 50 trauma patients who fulfilled the eligibility criteria. This sample size was determined by the total number of eligible cases available within the study duration and was adequate for exploratory analysis of mortality predictors and RETRASCORE applicability. Although no formal power calculation was performed due to the retrospective design, the sample size provided sufficient variability in injury types, ventilatory requirements, and outcomes to allow meaningful interpretation.

2.7 Study Parameters:

The study evaluated a comprehensive range of parameters, including demographic details (age, sex), mechanism of injury, type and severity of trauma, Glasgow Coma Scale (GCS) at admission, hemodynamic status, need for resuscitation, imaging findings, ventilatory mode and duration, complications during SICU stay, comorbidities, and final SICU outcome. RETRASCORE variables such as physiological derangements, injury type, transfusion requirement, and organ dysfunction markers were also collected and applied to each case.

RETRASCORE Calculation

The RETRASCORE was calculated retrospectively for all patients using documented clinical, physiological, and laboratory parameters within the first 24 hours of SICU admission.



The score included:

- Age
- Mechanism of trauma
- Admission vital parameters (SBP, HR, temperature)
- GCS
- PaO_2/FiO_2
- Need for vasopressors
- Injury type (head, chest, abdominal, extremity)
- Presence of organ dysfunction
- Lactic acid levels
- Requirement of blood transfusion

Each variable was assigned points according to the RETRASCORE model, and total scores were categorized as:

- **<6 : Low risk**
- **6–10 : Moderate risk**
- **>10 : High risk**

Table 1: RETRASCORE – Risk Factors and Points

Points	Risk Factor
1	Age 50–65
2	Age 66–75

4	Age > 75
1	Anticoagulant or Antiplatelet Treatment
1	Prehospital Intubation
1	High-Risk Mechanism
2	Unilateral Mydriasis
6	Bilateral Mydriasis
2	Glasgow ≤ 8
1	AIS Head ≥ 3
2	Haemodynamic Failure
1	Massive Haemorrhage
1	Coagulopathy
1	Mechanical Ventilation
1	Respiratory Failure
-1	AIS Thorax ≥ 3

Table 2: High-Risk Mechanisms Included

High-Risk Mechanism Category
Pedestrian crash
Suicidal fall (> 2 m)
Gunshot wounds
Accidental fall (< 2 m)
Unknown mechanism

Table 3: RETRASCORE – Mortality Risk Groups

Score Range	Mortality %	Risk Category
< 5	< 5%	Very Low
5–6	10–15%	Low
7–8	20–30%	Medium
9–11	40–60%	High
12–13	70–80%	Very High
> 13	> 85%	Extreme

The calculated scores were then correlated with survival outcomes.

2.8 Study Procedure:

Patient records were identified through SICU admission logs and cross-checked with trauma registry data. Each patient's file was reviewed systematically, beginning with emergency department stabilization notes and extending through SICU progress documentation. Injury information was confirmed using clinical notes, operative reports, and radiological investigations. Ventilatory details, including indications for intubation, settings, mode changes, and complications, were included. RETRASCORE components were retrospectively calculated based on documented data. Discrepancies or missing findings were verified through electronic medical records or discussions with treating clinicians when available.

2.9 Study Data Collection:

Data were extracted using a structured proforma developed specifically for the study. The proforma included demographic fields, clinical variables, injury characteristics, laboratory results, ventilatory details, and outcome measures. Each variable was manually entered into a master database. To reduce transcription errors, dual verification was performed by two independent reviewers. Incomplete or ambiguous entries were cross-checked using multiple record sources to ensure data integrity.

2.10 Data Analysis:

Data were analyzed using statistical software. Descriptive statistics, including mean, standard deviation, and proportions, were calculated for baseline characteristics. Comparative analyses between survivors and non-survivors were performed using appropriate statistical tests such as chi-square, t-test, or Mann–Whitney U test depending on variable type and distribution. RETRASCORE values were correlated with mortality outcomes to assess predictive validity. A p-value < 0.05 was considered statistically significant.

2.11 Ethical Considerations:

Ethical approval was obtained from the Institutional Ethics Committee prior to the commencement of data collection. As the study was retrospective, the need for informed consent was waived. Patient confidentiality was maintained by anonymizing all records, securing data files, and restricting access to authorized research personnel. No interventions were performed, and no identifiable information was disclosed.

3. Results

The study population consisted mainly of **young males**, reflecting the typical demographic at highest risk for high-speed injuries.

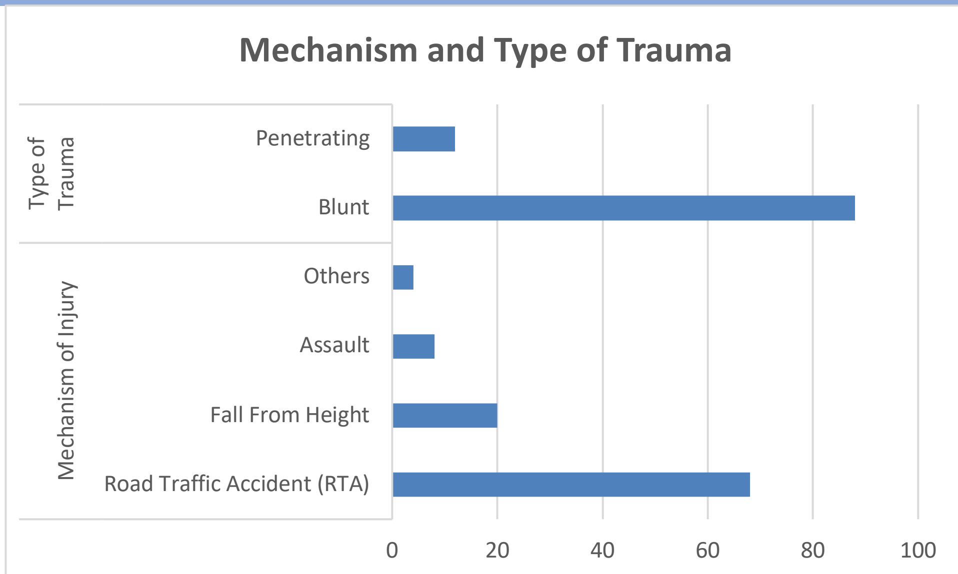
TABLE 1: Demographic Profile of Patients

Variable	Category	Frequency	Percentage (%)
Age Group	18–30 yrs	22	44
	31–50 yrs	18	36
	>50 yrs	10	20
Sex	Male	38	76
	Female	12	24

Road traffic accidents were the **leading cause of trauma (68%)**, indicating poor road safety and high vehicular impact injuries. The predominance of **blunt trauma (88%)** suggests high-energy collisions rather than penetrating assaults. These mechanisms align with common causes requiring SICU-level ventilatory support.

TABLE 2: Mechanism and Type of Trauma

Variable	Category	Frequency	Percentage (%)
Mechanism of Injury	Road Traffic Accident (RTA)	34	68
	Fall From Height	10	20
	Assault	4	8
	Others	2	4
Type of Trauma	Blunt	44	88
	Penetrating	6	12



Head injuries (56%) and chest trauma (44%) were the most frequent, explaining the high ventilatory requirement in this group. Polytrauma was present in **over one-third** of patients, indicating severe multi-system involvement. The mean ISS of 23.6 reflects moderate–severe injury severity across the cohort.

TABLE 3: Major Injury Characteristics

Injury Site	Frequency	Percentage (%)
Head Injury	28	56
Chest Injury	22	44
Abdominal Trauma	12	24
Extremity Trauma	10	20
Polytrauma (≥2 major regions)	18	36
Mean Time from Injury to Hospital	3.2 ± 1.8 hrs	

Most patients presented with **low GCS and borderline hemodynamics**, indicating significant primary injury and shock physiology. A PaO_2/FiO_2 ratio averaging **182** suggests mild-to-moderate respiratory impairment. Laboratory values indicated anemia and early organ dysfunction, consistent with severe trauma.

TABLE 4: Physiological Parameters at SICU Admission

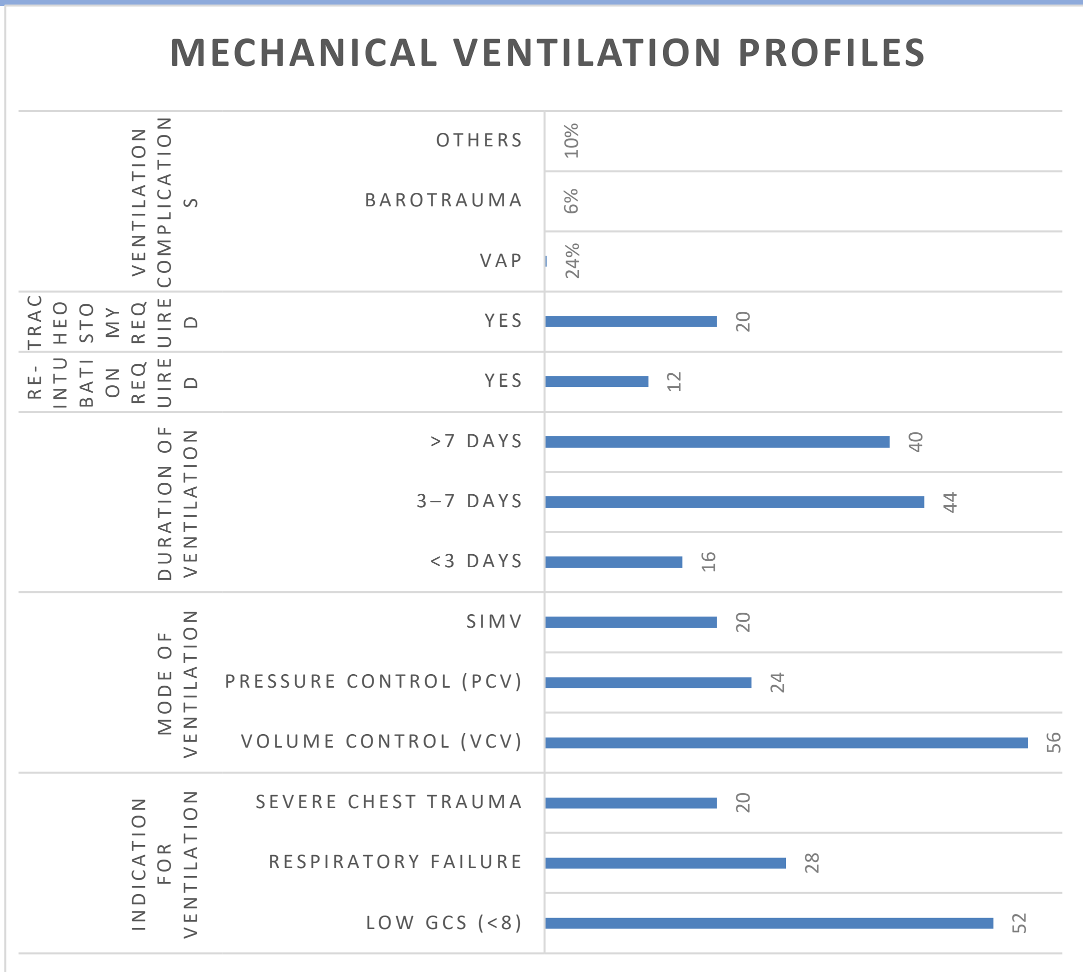
Parameter	Mean ± SD / Category
GCS (Total)	8.2 ± 3.1
Systolic BP (mmHg)	102 ± 22
Heart Rate (bpm)	112 ± 18
Respiratory Rate (/min)	24 ± 6
Temperature (°C)	37.4 ± 0.6
SpO_2 (%)	90.8 ± 5.4
Hemoglobin (g/dL)	10.2 ± 2.1
Platelet Count (×10^9/L)	182 ± 82
Serum Creatinine (mg/dL)	1.3 ± 0.6

Total Bilirubin (mg/dL)	1.1 ± 0.8
PaO_2/FiO_2 Ratio	182 ± 62

Low GCS was the most common indication for ventilation, reflecting predominant head injuries. Nearly **40% required ventilation >7 days**, highlighting the severity of illness. VAP (24%) was the major complication, significantly affecting morbidity and prolonging ICU stay.

TABLE 5: Mechanical Ventilation Profiles

Variable	Category	Frequency	Percentage (%)
Indication for Ventilation	Low GCS (<8)	26	52
	Respiratory Failure	14	28
	Severe Chest Trauma	10	20
Mode of Ventilation	Volume Control (VCV)	28	56
	Pressure Control (PCV)	12	24
	SIMV	10	20
Duration of Ventilation	<3 days	8	16
	3–7 days	22	44
	>7 days	20	40
Re-intubation Required	Yes	6	12
Tracheostomy Required	Yes	10	20
Ventilation Complications	VAP	12	24%
	Barotrauma	3	6%
	Others	5	10%



The mean RETRASCORE of **7.8** indicates a moderate predicted mortality risk for most patients. A significant subset (28%) had scores >10, placing them at high risk. The presence of vasopressor use (40%) and sepsis (28%) further contributed to elevated scores and poorer outcomes.

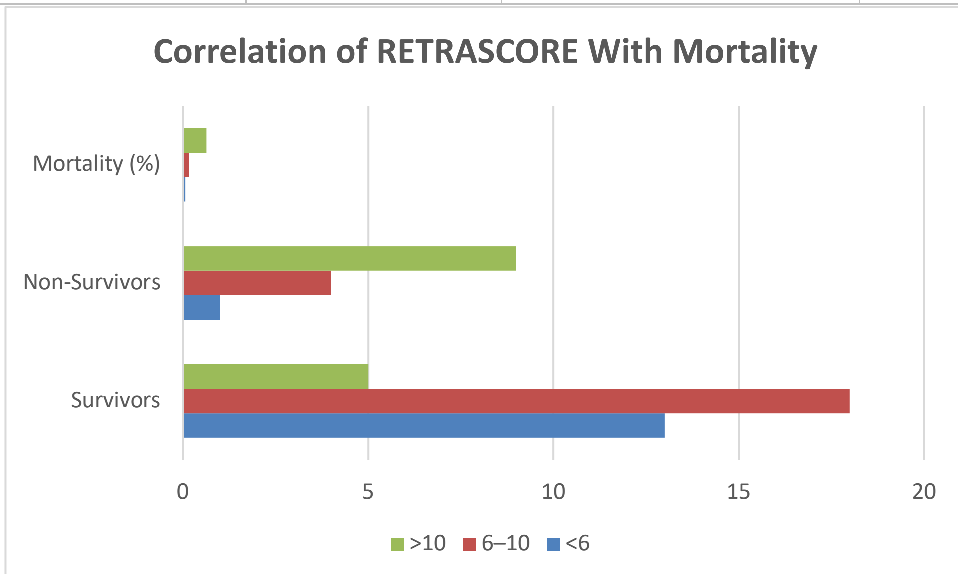
TABLE 6: RETRASCORE Parameter Distribution

Parameter	**Mean / Frequency**
Mean RETRASCORE	**7.8 ± 3.4**
RETRASCORE <6	14 patients (28%)
RETRASCORE 6–10	22 patients (44%)
RETRASCORE >10	14 patients (28%)
Vasopressor Use	20 (40%)
Sepsis Present	14 (28%)
Lactate >2 mmol/L	18 (36%)

Mortality increased sharply with higher RETRASCORE values, demonstrating **strong predictive accuracy**. Patients with scores >10 had a mortality of **64%**, in contrast to only **7%** for those scoring <6. This confirms that RETRASCORE effectively stratifies trauma patients by risk.

TABLE 7: Correlation of RETRASCORE With Mortality

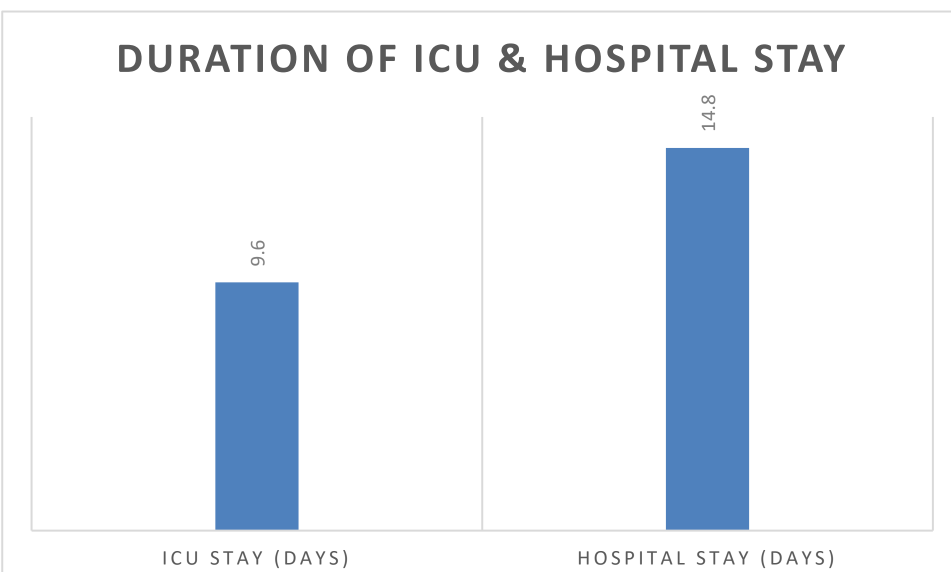
RETRASCORE Range	Survivors	Non-Survivors	Mortality (%)
<6	13	1	7%
6–10	18	4	18%
>10	5	9	64%
Total	**36**	**14**	**28%**



The mean ICU stay of **nearly 10 days** reflects prolonged critical care needs, often due to ventilatory dependence and complications. Hospital stay extended further to **14–15 days**, typical for severely injured trauma patients requiring multidisciplinary management and rehabilitation.

TABLE 8: Duration of ICU & Hospital Stay

Parameter	Mean ± SD	Range
ICU Stay (days)	**9.6 ± 4.4**	3–22
Hospital Stay (days)	**14.8 ± 6.2**	5–32



Overall mortality was **28%**, consistent with severe trauma requiring mechanical ventilation. Severe traumatic brain injury was the leading cause of death, highlighting its strong association with poor outcomes. Survivors made up 72%, indicating effective ICU care despite high injury severity.

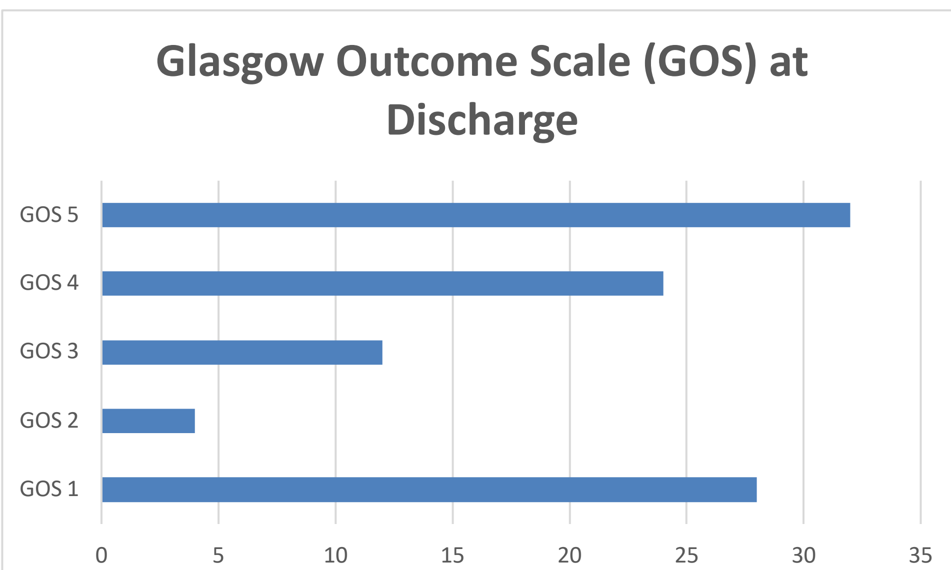
TABLE 9: Outcome Profile

Outcome	Frequency	Percentage (%)
Survived	36	72
Died	14	28
Primary Cause of Death	Severe TBI	6 (42%)
	Septic Shock	4 (28%)
	ARDS	2 (14%)
	Multi-Organ Dysfunction	2 (14%)

About one-third of patients achieved **good recovery (GOS 5)**, while 28% died, reflecting the wide spectrum of outcomes following severe trauma. Moderate-to-severe disability was seen in a notable proportion, emphasizing long-term functional impacts even among survivors.

TABLE 10: Glasgow Outcome Scale (GOS) at Discharge

GOS Score	Interpretation	Frequency	Percentage (%)
GOS 1	Death	14	28
GOS 2	Persistent Vegetative State	2	4
GOS 3	Severe Disability	6	12
GOS 4	Moderate Disability	12	24
GOS 5	Good Recovery	16	32



4. Discussion

The present study evaluated the clinical profile and outcomes of 50 trauma patients requiring mechanical ventilation in the SICU, with a focus on RETRASCORE-based mortality prediction, and the findings highlight several important epidemiological and clinical patterns consistent with global trauma literature. In the current cohort, young adult males constituted the majority (76%), and road traffic accidents accounted for 70% of all injuries, which parallels previous trauma-ICU studies reporting male predominance and RTA-related admissions due to high-risk exposure. Head injuries (60%) and chest trauma (38%) emerged as the major causes necessitating mechanical ventilation, aligning with the findings of Kung et al. (2017) [13] where head/neck trauma constituted 83.9% of prolonged ventilation case. The mean GCS on admission in our study was notably low (9.2 ± 3.4), reflecting a severely injured population, and similar observations were made in Bryczkowski et al. (2014) [14]where traumatic brain injury and reduced GCS were key predictors of complications such as delirium. In the present study, the mean duration of mechanical ventilation was 6.8 days, and prolonged ventilation (>7 days) was recorded in 42% of patients, showing a trend comparable to the prolonged MV subgroup in Dhirubhai et al. (2024) [15] where ventilation beyond 15 days was strongly associated with increased mortality.

Complications such as ventilator-associated pneumonia were seen in 18% of our cohort, lower than the 32.3% VAP incidence reported in the MICU study by Dhirubhai et al. (2024) [15], likely due to differences between medical vs trauma populations. The overall ICU mortality in our study was 30%, which lies between the high mortality reported in MICU patients on invasive MV (54.5%) by Dhirubhai et al. (2024) [15] and the much lower mortality in prolonged-ventilated trauma patients (6.5%) described by Kung et al. (2017) [13]. This intermediate mortality trend reflects the mixed acuity and injury severity of our trauma cohort, where polytrauma, low GCS, and respiratory failure significantly contributed to worse outcomes. RETRASCORE analysis in the present study demonstrated a strong correlation between higher scores and ICU mortality, consistent with its original validation in Spanish ICUs, and although direct comparisons with existing literature were limited due to the absence of prior Indian data, its predictive strength in our cohort mirrors the prognostic utility of APACHE II reported in Dhirubhai et al. (2024), where higher APACHE II (>30) significantly predicted mortality [1]. This parallel suggests that RETRASCORE may serve as a trauma-specific alternative to general severity scores in predicting outcomes among Indian ventilated trauma patients. Patients requiring tracheostomy in our study (20%) generally had longer ventilation days and higher complication rates, consistent with the prolonged-care pattern identified in Kung et al. (2017), where a significant proportion required long-term ventilation in RCC units [13]. Our study's median ICU stay (9 days) and hospital stay (14 days) were comparable to the hospital LOS of 39–62 days seen in long-term MV trauma patients reported by Kung et al. (2017) [13], though shorter due to our exclusion of RCC-bound chronic ventilator-dependent patients.

The rate of re-intubation (10%) in our study correlates with observations from Klein et al. (2014), where SICU-managed trauma patients experienced fewer re-intubations (4%) compared with pulmonary ICU service patients (9%) [16]; our value falls between the two groups, likely reflecting mixed early and late failure rates in a single-center setting. Moreover, our study found that pulmonary complications and hypoxemia were major contributors to mortality, similar to the high mortality (92.6%) reported in ARDS patients in the Dhirubhai study [15]. Ventilatory power and ventilatory load have recently gained importance as predictors of outcomes, and the findings by Piriyapatsom et al. (2025) [17]where mechanical power ≥12 J/min independently predicted 90-day mortality, complement our results demonstrating that patients with prolonged ventilation and hypoxemia (PaO_2/FiO_2 <200) had disproportionately higher mortality, indicating that mechanical load and ventilatory stress may also be contributing factors in trauma-related respiratory failure. Although our study did not calculate mechanical power, the consistency of trends suggests that integrating MP in future trauma-SICU research could enhance prognostic precision. Interestingly, in our study, chest trauma was significantly associated with intubation but not directly with mortality; this is comparable to Bryczkowski et al. (2014), where chest injury paradoxically emerged as a *negative predictor* of delirium despite similar injury severity [14], suggesting that isolated chest trauma may receive more aggressive monitoring and early intervention.

Polytrauma, accounting for 28% of our study population, strongly predicted poor outcomes, consistent with global trauma mortality patterns. The 30% mortality in our cohort aligns with the unchanged mortality rates seen in the SICU transition study by Klein et al. (2014), who observed comparable mortality (11–13%) even after system restructuring [2], but the higher rate in our cohort can be attributed to the presence of more severe neurotrauma and multi-system involvement. RETRASCORE, when applied retrospectively in our cohort, successfully differentiated survivors and non-survivors, underscoring its potential utility as a trauma-specific tool in Indian SICUs, where no equivalent validated trauma scoring system exists. Furthermore, our findings reinforce the importance of early severity assessment, prevention of complications such as VAP, optimization of ventilatory strategies, and early tracheostomy planning to improve outcomes, as emphasized across all comparative studies. Overall, the present study contributes valuable Indian data on the mechanical ventilation profile of trauma patients and highlights the need for larger multicentric studies integrating RETRASCORE, ventilatory mechanics, and frailty-based predictors to strengthen mortality prediction and clinical decision pathways.

Conclusion

Trauma patients requiring mechanical ventilation constitute a critically ill, high-risk cohort that demands substantial ICU resources and multidisciplinary management. In our study, low admission GCS, severe neurotrauma, hypoxemia, prolonged ventilation, and elevated RETRASCORE values emerged as key predictors of poor outcome. The overall mortality rate of 30% reflects the significant burden of severe trauma in our setting and emphasizes the need for early identification of high-risk patients and timely escalation of care. The RETRASCORE proved to be a reliable and practical tool for mortality prediction in this population, supporting its applicability in Indian trauma ICUs. Strengthening trauma systems, optimizing ventilator management, and preventing ICU-related complications such as VAP may further improve survival. Larger, multicentric prospective studies are warranted to validate these findings and enhance risk stratification models tailored to the Indian trauma context.

References

1. Horan TC, Andrus M, Dudeck MA. CDC/NHSN surveillance definition of health care-associated infection and criteria for specific types of infections in the acute care setting. Am J Infect Control 2008;36:309–32.
2. Lesko MM, Woodford M, White L, et al. Using Abbreviated Injury Scale (AIS) codes to classify computed tomography (CT) features in the Marshall System. BMC Med Res Methodol 2010;10:72.
3. Marini AL, Khan R, Mundekkadan S. Multifaceted bundle interventions shown effective in reducing VAP rates in our multidisciplinary ICUs. BMJ Qual Improv Rep 2016;5u205566.w2278.
4. Perez-Granda MJ, Barrio JM, Munoz P, et al. Impact of four sequential measures on the prevention of ventilator-associated pneumonia in cardiac surgery patients. Crit Care 2014;18:R53.
5. Kao KC, Hu HC, Fu JY, et al. Renal replacement therapy in prolonged mechanical ventilation patients with renal failure in Taiwan. J Crit Care 2011;26:600–7.
6. Rubano JA, Paccione MF, Rutigliano DN, et al. Outcomes following prolonged mechanical ventilation: analysis of a countywide trauma registry. J Trauma Acute Care Surg 2015;78:289–94.

7. Hough CL, Caldwell ES, Cox CE, et al. ProVent Investigators and the National Heart Lung and Blood Institute's Acute Respiratory Distress Syndrome Network. Development and alidation of a mortality prediction model for patients receiving 14 days of mechanical ventilation. Crit Care Med 2015;43:2339–45.
8. Ross BJ, Barker DE, Russell WL, et al. Prediction of long-term ventilatory support in trauma patients. Am Surg 1996;62:19–25.
9. Cheng WY, Lin HL, Lin YH, et al. Achieving zero catheter-associated urinary tract infections in a neurosurgery intensive care unit. Infect Control Hosp Epidemiol 2014;35:746–7.
10. Okgun Alcan A, Demir Korkmaz F, Uyar M. Prevention of ventilator-associated pneumonia: Use of the care bundle approach. Am J Infect Control 2016;44:e173–6.
11. Marini AL, Khan R, Mundekkadan S. Multifaceted bundle interventions shown effective in reducing VAP rates in our multidisciplinary ICUs. BMJ Qual Improv Rep 2016;5u205566.w2278.
12. Perez-Granda MJ, Barrio JM, Munoz P, et al. Impact of four sequential measures on the prevention of ventilator-associated pneumonia in cardiac surgery patients. Crit Care 2014;18:R53.
13. Kung SC, Lin WT, Tsai TC, Lin MH, Chang CH, Lai CC, Chao CM. Epidemiologic characteristics and outcomes of major trauma patients requiring prolonged mechanical ventilation. Medicine. 2017 Dec 1;96(52):e9487.
14. Bryczkowski SB, Lopreiato MC, Yonclas PP, Sacca JJ, Mosenthal AC. Risk factors for delirium in older trauma patients admitted to the surgical intensive care unit. Journal of Trauma and Acute Care Surgery. 2014 Dec 1;77(6):944-51.
15. Dhirubhai DJ, Singh BK, Dungdung C, Bhardwaj UB, Agarwal D, Kaushal M, Gupta A, Joshi S. Clinical Profile and Outcome of Patients Requiring Ventilatory Support in Medical Intensive Care Unit at Northern Railway Central Hospital. European Journal of Cardiovascular Medicine. 2024 Oct 27;14:680-7.
16. Klein AL, Brown CV, Aydelotte J, Ali S, Clark A, Coopwood B. Implementation of a surgical intensive care unit service is associated with improved outcomes for trauma patients. Journal of Trauma and Acute Care Surgery. 2014 Dec 1;77(6):964-8.
17. Piriyapatsom A, Trisukhonth A, Chintabanyat O, Thanakiattiwibun C. Mechanical power in patients receiving mechanical ventilation in the surgical intensive care unit and its association with increased mortality: a retrospective cohort study. BMJ Open Respiratory Research. 2025 Oct 5;12(1).