e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(3); 578-582

Original Research Article

Clinical and Biochemical Predictors of Outcome in Polytrauma Patients with Hypovolemic Shock: A Prospective Observational Study

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Received: 01-12-2025 /Revised: 15-01-2026 / Accepted: 21-02-2026

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Conflict of interest: Nil

Abstract

Background: Polytrauma remains a major cause of mortality and morbidity worldwide, particularly among young adults. Hypovolemic shock is the most common preventable cause of early death in trauma patients. Early identification of predictors of outcome in polytrauma patients is essential for timely intervention and improved survival.

Objectives: To identify clinical and biochemical predictors of outcome in polytrauma patients presenting with hypovolemic shock.

Methods: A prospective observational study was conducted among 50 polytrauma patients with hypovolemic shock admitted to the General Surgery Department of a tertiary care Government Hospital. Demographic characteristics, injury profile, physiological parameters, laboratory investigations including serum lactate levels, and injury severity scores were recorded. Outcomes were categorized as survival or mortality. Statistical analysis was performed to determine associations between clinical variables and outcomes.

Results: Among the 50 patients included in the study, 40 patients (80%) survived while 10 patients (20%) died. Higher admission lactate levels, lower lactate clearance, higher injury severity scores, and lower systolic blood pressure at admission were associated with poorer outcomes.

Conclusion: Serum lactate levels, lactate clearance, and injury severity scores are important predictors of outcome in polytrauma patients presenting with hypovolemic shock. Early identification of these predictors may assist clinicians in identifying high-risk patients and guiding aggressive resuscitative strategies.

Keywords: Polytrauma, hypovolemic shock, predictors of outcome, lactate clearance, injury severity score.

DOI: 10.25258/ijcpr.18.3.90

Introduction

Trauma is a major public health problem worldwide and represents one of the leading causes of mortality and disability, particularly among young adults. Globally, injuries account for nearly five million deaths each year and contribute substantially to disability-adjusted life years, especially in low- and middle-income countries [1].

Polytrauma patients, defined as individuals sustaining injuries involving multiple body regions with at least one life-threatening injury, represent a particularly severe subset of trauma cases and are associated with increased morbidity and mortality [2]. Hypovolemic shock is the most common and preventable cause of early mortality in trauma patients. It results primarily from acute blood loss following severe injury, leading to inadequate tissue perfusion and cellular hypoxia. If not promptly recognized and treated, hypovolemic shock may progress to multiple organ dysfunction syndrome and death [3]. Early recognition of high-risk patients is therefore essential to improve outcomes in trauma care. Traditionally, clinical parameters such as blood pressure, heart rate, respiratory rate, and urine output have been used to assess the severity of shock and guide resuscitation. However, these parameters may not accurately reflect the degree of tissue hypoperfusion. Compensatory physiological mechanisms can maintain near-normal vital signs despite ongoing cellular hypoxia, leading to delayed recognition of shock [4].

This phenomenon, known as occult hypoperfusion, has been associated with increased morbidity and mortality in trauma patients [5]. In recent years,

biochemical markers have gained increasing attention as potential indicators of tissue hypoxia and predictors of outcome in critically ill patients. Serum lactate is one such marker and is produced during anaerobic metabolism when oxygen delivery to tissues is inadequate. Elevated lactate levels have been shown to correlate with the severity of shock, extent of tissue injury, and mortality in trauma patients [6]. Therefore, serum lactate measurement has become an important tool in the early assessment of critically injured patients.

Serial measurements of serum lactate provide additional prognostic information. Lactate clearance, defined as the percentage reduction in lactate levels over time, reflects restoration of tissue perfusion and effectiveness of resuscitative efforts. Several studies have demonstrated that higher lactate clearance is associated with improved survival in critically ill patients [7]. Conversely, persistent hyperlactatemia may indicate ongoing tissue hypoxia and inadequate resuscitation.

Apart from biochemical parameters, injury severity scoring systems are also widely used to predict outcomes in trauma patients. The Injury Severity Score (ISS) is one of the most commonly used scoring systems for assessing trauma severity. Higher ISS values have been shown to correlate with increased mortality and complication rates in polytrauma patients [8].

Previous studies have suggested that a combination of clinical parameters, biochemical markers, and injury severity scores may provide valuable information for predicting outcomes in trauma patients. Early identification of high-risk patients allows clinicians to prioritize treatment, allocate resources effectively, and initiate aggressive resuscitation when necessary [9].

Despite advances in trauma care, mortality associated with polytrauma remains high, particularly in developing countries. Limited data are available from tertiary care centres in India regarding predictors of outcome in polytrauma patients presenting with hypovolemic shock.

Therefore, this study was undertaken to identify clinical and biochemical predictors of outcome in polytrauma patients with hypovolemic shock admitted to a tertiary care Hospital.

Understanding these predictors may help clinicians identify high-risk patients early and improve trauma management strategies. This study was done with the objectives

1. To identify clinical predictors of outcome in polytrauma patients with hypovolemic shock.
2. To evaluate biochemical parameters associated with mortality in polytrauma patients.
3. To assess the relationship between injury severity and patient outcomes.

Materials and Methods

Study Design: This study was designed as a prospective observational study conducted to evaluate clinical and biochemical predictors of outcome in polytrauma patients presenting with hypovolemic shock.

Study Setting: The study was conducted in the Department of General Surgery of a tertiary care Government Hospital in Tamil Nadu, India, which functions as a major referral center for trauma care.

Study Population: The study population consisted of polytrauma patients presenting with hypovolemic shock who were admitted to the emergency department and taken over by the Department of General Surgery during the study period.

Sample Size: A total of 50 patients who fulfilled the inclusion criteria were included in the study.

Inclusion Criteria: Patients were included in the study if they met the following criteria:

- Age 18 years or older
- Diagnosis of polytrauma with hypovolemic shock
- Patients admitted to the emergency department and taken over by the Department of General Surgery during the study period

Exclusion Criteria

Patients with the following conditions were excluded from the study:

- Septic shock
- Cardiogenic shock
- Known chronic liver disease
- Patients who expired before completion of initial clinical and laboratory evaluation

Data Collection

After admission, relevant clinical and laboratory data were collected for each patient using a structured data collection form. The following variables were recorded:

- Demographic characteristics including age and gender
- Mechanism of injury, including road traffic accident, fall, or assault
- Time elapsed since injury before presentation to the hospital
- Hemodynamic parameters, including blood pressure and heart rate at admission
- Laboratory investigations, including serum lactate levels
- Injury Severity Score (ISS) for assessment of trauma severity

- Patient outcome, categorized as survived or died during the hospital course

Statistical Analysis: Data were analyzed using Statistical Package for the Social Sciences (SPSS) software. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Comparisons between survivors and non-survivors were performed using independent sample t-tests for continuous variables and chi-square tests for categorical variables. A p-value < 0.05 was considered statistically significant.

Results

Table 1: Demographic Characteristics of Study Participants Clinical and Biochemical Predictors of Outcome in Polytrauma Patients with Hypovolemic Shock

Variable	Number (%)
Male	29 (58%)
Female	21 (42%)
Mean age	42.24 ± 16.99 years

Among the 50 polytrauma patients included in the study, 29 patients (58%) were male and 21 patients (42%) were female, indicating a predominance of male patients. The mean age of the study population was 42.24 ± 16.99 years, suggesting that trauma predominantly affected individuals in the middle-aged population.

Table 2: Mode of Injury of Study Participants Clinical and Biochemical Predictors of Outcome in Polytrauma Patients with Hypovolemic Shock

Mode of Injury	Number (%)
Fall	18 (36%)
Road traffic accident	17 (34%)
Assault	15 (30%)

The most common mechanism of injury observed in the study was fall, accounting for 18 cases (36%), followed by road traffic accidents in 17 patients (34%) and assault in 15 patients (30%). These findings suggest that both accidental and interpersonal injuries contribute significantly to polytrauma cases in the study population.

Table 3: Patient Outcomes of Study Participants Clinical and Biochemical Predictors of Outcome in Polytrauma Patients with Hypovolemic Shock

Outcome	Number (%)
Survived	40 (80%)
Died	10 (20%)

Among the 50 patients included in the study, 40 patients (80%) survived, while 10 patients (20%) died during the course of treatment. This mortality rate reflects the severity of injuries and physiological compromise associated with polytrauma and hypovolemic shock.

Table 4: Comparison of Clinical Variables between Survivors and Non-Survivors of Study Participants Clinical and Biochemical Predictors of Outcome in Polytrauma Patients with Hypovolemic Shock

Variable	Survivors (n=40)	Non-survivors (n=10)	p-value
Mean age (years)	40.3 ± 15.8	49.2 ± 18.4	0.18
Initial serum lactate (mmol/L)	4.21 ± 1.02	5.62 ± 1.14	0.001
Lactate clearance (%)	41.2 ± 8.6	21.5 ± 7.4	<0.001
Injury Severity Score	19.4 ± 5.2	28.3 ± 6.1	0.002
Admission SBP (mmHg)	83.6 ± 7.9	72.4 ± 6.8	0.004

Comparison between survivors and non-survivors demonstrated significant differences in several clinical parameters. Non-survivors had significantly higher admission lactate levels (5.62 mmol/L) compared to survivors (4.21 mmol/L). Lactate clearance was markedly lower in non-survivors (21.5%) compared to survivors (41.2%). Injury Severity Score was also significantly higher in non-survivors (28.3) compared to survivors (19.4). Admission systolic blood pressure was significantly lower among non-survivors (72.4 mmHg) compared to survivors (83.6 mmHg). These findings suggest that higher lactate levels, lower lactate clearance, higher injury severity, and hypotension are associated with increased mortality risk.

Discussion

Polytrauma is a major cause of mortality worldwide, and early identification of predictors of outcome is essential to improve trauma management. The present study evaluated clinical and biochemical predictors of outcome in polytrauma patients presenting with hypovolemic

shock. The demographic profile of the study population revealed a predominance of male patients, accounting for 58% of cases. This finding is consistent with previous studies that have reported higher incidence of trauma among males due to greater exposure to high-risk activities and occupational hazards [2,6]. The mean age of patients in this study was approximately 42 years, indicating that trauma primarily affects individuals in their economically productive years.

The most common mechanism of injury observed in the present study was fall, followed closely by road traffic accidents and assault. Road traffic injuries remain one of the leading causes of trauma worldwide, particularly in developing countries where rapid urbanization and increasing motor vehicle use contribute to rising injury rates [1].

The mortality rate observed in this study was 20%. Mortality in polytrauma patients is influenced by several factors including severity of injuries, extent of blood loss, associated organ damage, and adequacy of resuscitation. Early identification of high-risk patients therefore plays an important role in improving outcomes.

One of the important findings of this study was the association between elevated admission lactate levels and poor outcomes. Lactate is produced during anaerobic metabolism and accumulates when oxygen delivery to tissues is insufficient. Elevated serum lactate levels therefore indicate tissue hypoxia and inadequate perfusion [6]. Several studies have demonstrated that higher lactate levels at admission are associated with increased mortality in trauma patients [7].

In addition to admission lactate levels, lactate clearance was also found to be an important predictor of outcome in this study. Patients who survived demonstrated significantly higher lactate clearance compared to those who died. Lactate clearance reflects restoration of tissue perfusion and adequacy of resuscitation. Failure to clear lactate indicates persistent tissue hypoxia and inadequate resuscitation and has been associated with poorer outcomes in critically ill patients [7,9]. The Injury Severity Score was another significant predictor of outcome identified in this study. Non-survivors had significantly higher ISS compared to survivors, indicating greater injury burden. ISS is widely used to assess trauma severity and has been shown to correlate with mortality risk in polytrauma patients [8].

Hypotension at admission was also associated with increased mortality in this study. Lower systolic blood pressure reflects more severe circulatory compromise and inadequate tissue perfusion. Early recognition and aggressive management of hypotension are therefore crucial in trauma resuscitation.

The findings of this study highlight the importance of combining clinical parameters, biochemical markers, and injury severity scoring systems to predict outcomes in polytrauma patients. Such an integrated approach may help clinicians identify high-risk patients early and guide appropriate management strategies.

Conclusion

Serum lactate levels, lactate clearance, injury severity score, and admission systolic blood pressure are important predictors of outcome in polytrauma patients presenting with hypovolemic shock. Early identification of these predictors may assist clinicians in identifying high-risk patients and initiating timely and aggressive resuscitative interventions.

Strengths: This study has several strengths. It employed a prospective observational design with systematic data collection from polytrauma patients presenting with hypovolemic shock. The study evaluated both clinical and biochemical predictors of outcome, providing a comprehensive assessment of factors influencing patient survival.

Limitations: The study was conducted in a single tertiary care center with a relatively small sample size, which may limit the generalizability of the findings. In addition, long-term outcomes such as intensive care stay, complications, and functional recovery were not evaluated.

Recommendations: Future multicenter studies with larger sample sizes are recommended to validate these findings. Incorporating biochemical markers such as lactate clearance along with injury severity scores may improve early risk stratification in trauma patients.

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