

Prognostic Role of HALP Score, CALLY Index, and Prognostic Nutritional Index in Polytrauma Patients Followed in the Intensive Care Unit: A Retrospective Cohort Study

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Abstract

Background

The prognostic role of immunological and nutritional scores in trauma patients, as in various other diseases, has been increasingly investigated. In this study, we evaluated the associations of the hemoglobin–albumin–lymphocyte–platelet (HALP) score, C-reactive protein–albumin–lymphocyte (CALLY) index, and Prognostic Nutritional Index (PNI) with in-hospital mortality and compared their prognostic performance in patients with polytrauma admitted to the intensive care unit (ICU).

Methods

This retrospective cohort study included 162 adult patients who were admitted to the ICU between June 2021 and June 2023 and diagnosed with polytrauma according to the Berlin criteria. The HALP score, CALLY index, and PNI were calculated using laboratory parameters obtained at admission. The primary outcome was in-hospital mortality. The independent prognostic value of the indices was assessed using logistic regression models, while their discriminative performance was evaluated using receiver operating characteristic (ROC) curve analysis.

Results

In-hospital mortality occurred in 19 patients (11.7%). Non-survivors had lower Glasgow Coma Scale (GCS) scores [3 (3–5) vs. 10 (7–13); $p < 0.001$] and higher Acute Physiology and Chronic Health Evaluation II (APACHE II) [25 (22–30) vs. 14 (9–19); $p < 0.001$] and Injury Severity Score (ISS) scores [41 (25–41) vs. 20 (18–27); $p < 0.001$]. Patients who died had lower CALLY [1.1 (0.3–4.9) vs. 3.4 (0.9–11.8); $p = 0.036$] and PNI [31.0 (21.0–37.0) vs. 38.0 (33.0–42.0); $p = 0.001$] values, whereas no significant difference was observed in HALP scores [1.9 (1.3–3.2) vs. 2.3 (1.6–3.5); $p = 0.605$]. In multivariable analysis, PNI was the only index independently associated with mortality after adjustment for ISS and GCS (OR = 0.803; 95% CI: 0.704–0.916; $p = 0.001$). Neither HALP (OR = 0.959; $p = 0.611$) nor CALLY (OR = 0.966; $p = 0.194$) demonstrated independent prognostic value. In standalone ROC analysis, PNI showed the numerically highest discriminative performance (AUC = 0.740; 95% CI: 0.607–0.873), whereas the AUC values for CALLY and HALP were 0.648 and 0.537, respectively.

Conclusions

PNI was independently associated with in-hospital mortality in ICU patients with polytrauma and demonstrated the numerically highest discriminative performance among the indices evaluated.

Introduction

Trauma is a major cause of mortality and morbidity, particularly among younger individuals. Polytrauma represents one of the most complex patient populations in critical care, as it involves injuries affecting multiple anatomical regions or organ systems. The prognosis of patients with polytrauma is determined not only by the anatomical severity of the primary injury but also by interconnected processes such as hemorrhage, tissue hypoperfusion, systemic inflammatory response, immune dysfunction, infection, and multiple organ failure [1]. In particular, uncontrolled inflammation following severe trauma and the accompanying immunosuppression may influence not only early physiological deterioration but also late complications and mortality. Therefore, early and reliable prediction of mortality risk in patients with polytrauma admitted to the intensive care unit (ICU) is important for patient triage, determining the intensity of treatment, and clinical decision-making [2].

The hypermetabolic and catabolic responses that occur during critical illness and severe trauma are closely associated with inflammation and alterations in immune function. During this process, decreased serum albumin levels, lymphopenia, hematological abnormalities, and elevated acute-phase reactants are frequently observed, and these parameters may provide prognostic information regarding disease severity and clinical outcomes [3–6]. Indeed, nutritional indices calculated at admission have been shown to be associated with both in-hospital and long-term mortality in critically ill trauma patients [5–7]. However, a single laboratory parameter may not adequately reflect the complex interplay among inflammation, immune response, and nutritional reserve. Therefore, easily calculable and low-cost composite indices derived from different combinations of routinely available laboratory parameters have attracted increasing interest for prognostic risk stratification in critically ill patients.

Among the indices used for this purpose, the hemoglobin–albumin–lymphocyte–platelet (HALP) score integrates hematological, nutritional, and immune-inflammatory status into a single measure, whereas the C-reactive protein–albumin–lymphocyte (CALLY) index evaluates the severity of systemic inflammation in conjunction with nutritional reserve and immune competence. The Prognostic Nutritional Index (PNI), calculated from serum albumin concentration and peripheral lymphocyte count, is a more established indicator reflecting immunonutritional status [8, 9]. Recent studies have reported that a low HALP score is associated with increased short-term and in-hospital mortality in critically ill patients, that a low CALLY index may have prognostic value for mortality in severe inflammatory conditions such as sepsis, and that low PNI values are associated with adverse outcomes in critically ill patients [5, 10, 11]. However, the prognostic performance of these indices may vary across patient populations, and data directly comparing the ability of HALP, CALLY, and PNI to predict in-hospital mortality within the same cohort of ICU patients with polytrauma remain limited.

The aim of this study was to investigate the value of the HALP score, CALLY index, and Prognostic Nutritional Index, calculated from laboratory parameters obtained at admission, for predicting in-hospital mortality in patients with polytrauma admitted to the ICU and to compare the prognostic performance of these three indices.

Methods

Patients and Study Design

This retrospective observational study was initiated after obtaining approval from the Clinical Research Ethics Committee of Istanbul Kanuni Sultan Süleyman Training and Research Hospital (date: January 28, 2026; approval no.: KAEK/2026.01.25). The study was conducted in accordance with the principles of the Declaration of Helsinki. Medical records of patients with polytrauma who were admitted to and treated in the ICU of University of Health Sciences, Istanbul Kanuni Sultan Süleyman Training and Research Hospital between June 2021 and June 2023 were retrospectively reviewed. Polytrauma was defined according to the Berlin definition [12].

Inclusion criteria are as follows:

1. Age ≥ 18 years,
2. Diagnosis of polytrauma according to Berlin criteria,
3. Admitted to ICU within 24 hours after trauma.

Exclusion criteria included:

1. Cardiopulmonary resuscitation following trauma,
2. Pregnancy,
3. Viral or bacterial infection within the preceding two weeks,
4. Severe hepatorenal disease, chronic renal or hepatic failure
5. Transfer from another healthcare facility
6. Missing data.

Demographic characteristics, type and etiology of trauma, comorbidities, length of ICU stay, trauma scores, and in-hospital mortality were recorded. Glasgow Coma Scale (GCS), Acute Physiology and Chronic Health Evaluation-II (APACHE-II), Revised Trauma Score (RTS), and Injury Severity Score (ISS; calculated as the sum of the squares of the Abbreviated Injury Scale [AIS] scores of the three most severely injured body regions) at ICU admission were analyzed, along with routinely measured admission laboratory parameters, including hemoglobin, lymphocyte count, platelet count, C-reactive protein (CRP), and albumin levels. Patients were classified into two groups according to in-hospital outcome: survivors and non-survivors. Patient data were obtained from the hospital electronic medical record system and patient files.

Calculation of HALP Score, CALLY Index, and Prognostic Nutritional Index

Hemoglobin, serum albumin, CRP, absolute lymphocyte count, and platelet count values of the patients included in the study were retrospectively obtained from the hospital electronic database and patient

records. To minimize the potential effects of fluid resuscitation, blood product transfusion, and other therapeutic interventions administered after trauma on laboratory parameters, the first eligible laboratory results obtained at hospital admission were used to calculate the indices. The hemoglobin–albumin–lymphocyte–platelet (HALP) score, a composite index reflecting both systemic inflammatory and nutritional status, was calculated using the following formula: $\text{HALP} = \text{hemoglobin (g/L)} \times \text{albumin (g/L)} \times \text{absolute lymphocyte count } (\times 10^9/\text{L}) / \text{platelet count } (\times 10^9/\text{L})$ (8,13).

The C-reactive protein–albumin–lymphocyte (CALLY) index was calculated as an indicator integrating systemic inflammation, nutritional status, and immune response. The following formula was used: $\text{CALLY} = \text{albumin (g/dL)} \times \text{absolute lymphocyte count } (/ \text{mm}^3) / [\text{CRP (mg/dL)} \times 10^4]$ [11,14]. Because different scaling approaches have been reported in the literature depending on the laboratory units used to calculate the CALLY index, all laboratory values in the present study were standardized to the specified units before calculation. This ensured that CALLY values were calculated using the same mathematical approach for all patients.

The Prognostic Nutritional Index (PNI) was calculated using serum albumin levels and peripheral blood absolute lymphocyte counts according to the following formula: $\text{PNI} = [10 \times \text{serum albumin (g/dL)}] + [0.005 \times \text{absolute lymphocyte count } (/ \text{mm}^3)]$ [5,15]. HALP, CALLY, and PNI values were not extracted as pre-existing values from patient records; instead, each index was calculated separately from baseline laboratory parameters within the dataset created for this study. In the primary analyses, all three indices were evaluated as continuous variables, while their discriminative performance for predicting mortality and their optimal cutoff values were determined using receiver operating characteristic (ROC) curve analyses.

Sample size

As this study was conducted using a retrospective cohort design, no prospective sample size calculation was performed at study initiation. The sample size was determined by consecutively evaluating all eligible patients who were treated in the intensive care unit for polytrauma during the predefined study period and met the study inclusion criteria. Patients for whom the HALP score, CALLY index, or PNI could not be calculated because of missing or insufficient clinical or laboratory data were excluded. Accordingly, the final analysis included all patients who met the eligibility criteria during the study period and had the data required to assess the primary outcome and the prognostic indices.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was assessed using the Shapiro–Wilk test and visual inspection of histograms. Normally distributed continuous variables were expressed as mean $\pm$ standard deviation, whereas non-normally distributed continuous variables were presented as median and interquartile range [IQR; Q1–Q3]. Categorical variables were presented as number and percentage [n (%)]. For comparisons between patients who died during hospitalization and those who survived, the

independent-samples t-test was used for normally distributed continuous variables, whereas the Mann–Whitney U test was used for non-normally distributed continuous variables. Categorical variables were compared using Pearson’s chi-square test or Fisher’s exact test when expected cell counts were insufficient.

The discriminative performance of the HALP score, CALLY index, and PNI for in-hospital mortality was evaluated using receiver operating characteristic (ROC) curve analysis. For each index, the area under the curve (AUC) and its 95% confidence interval (95% CI) were calculated. Optimal cutoff values were determined using the Youden index (sensitivity + specificity – 1), and sensitivity and specificity were reported for the identified cutoff values. As no formal statistical comparison of the AUCs of HALP, CALLY, and PNI was performed, the discriminative performance of the indices was evaluated descriptively based on the numerical magnitude of their AUC values.

Firth’s penalized logistic regression analysis was used to evaluate the independent associations of HALP, CALLY, and PNI with in-hospital mortality. Because the indices share laboratory components and the number of mortality events was limited, all three indices were not entered simultaneously into the same regression model. Instead, HALP, CALLY, and PNI were evaluated in separate models, with each model adjusted for ISS and GCS score. The indices were entered into the regression models as continuous variables. Regression results were reported as adjusted odds ratios (ORs) with 95% CIs. The discriminative performance of each model was assessed using the area under the ROC curve. All statistical tests were two-sided, and a p-value <0.05 was considered statistically significant.

Results

Demographic and Clinical Characteristics of the Patients

A total of 162 patients with polytrauma were included in the study. Of these, 143 (88.3%) were discharged alive, whereas 19 (11.7%) died during hospitalization (Fig. 1). The mean age of the overall cohort was 38.4 ± 17.4 years, and 127 patients (78.4%) were male. No significant differences were observed between survivors and non-survivors in terms of age (37.8 ± 17.1 vs. 42.8 ± 19.7 years; $p = 0.247$), sex ($p = 0.563$), type of trauma ($p = 0.704$), or presence of comorbidities ($p = 0.775$). Blunt trauma was present in 92.6% of patients, whereas 7.4% had penetrating trauma.

The requirement for renal replacement therapy (RRT) was markedly higher in non-survivors than in survivors (73.7% vs. 9.8%; $p < 0.001$). In addition, the length of ICU stay was longer in the non-survivor group [14 (5–27) vs. 7 (4–12) days; $p < 0.001$].

Marked differences between the groups were observed in terms of injury severity and physiological status. Patients who died had lower median Glasgow Coma Scale (GCS) scores [3 (3–5) vs. 10 (7–13); $p < 0.001$] and Revised Trauma Scores (RTS) [2 (1–2) vs. 2 (2–3); $p < 0.001$], whereas their Acute Physiology and Chronic Health Evaluation II (APACHE II) scores [25 (22–30) vs. 14 (9–19); $p < 0.001$] and Injury Severity Scores (ISS) [41 (25–41) vs. 20 (18–27); $p < 0.001$] were significantly higher.

Regarding laboratory parameters, non-survivors had lower hemoglobin levels (10.7 ± 2.7 vs. 12.2 ± 2.4 g/dL; $p = 0.013$), higher C-reactive protein (CRP) levels [21.5 (6.2 – 176.2) vs. 13.1 (3.3 – 41.8) mg/L; $p = 0.042$], and lower serum albumin levels (2.9 ± 0.8 vs. 3.7 ± 0.6 g/dL; $p = 0.001$). No significant differences were observed between the groups in lymphocyte or platelet counts ($p = 0.177$ and $p = 0.156$, respectively).

Trauma Etiologies and Injury Patterns

Regarding trauma etiology, motor vehicle accidents were the most common cause, occurring in 78 patients (48.1%), followed by falls in 59 patients (36.4%). Assault-related injuries and firearm- or explosion-related injuries were each observed in 9 patients (5.6%), whereas occupational/crush injuries and stab or penetrating injuries were less frequent.

Regarding injury patterns, head injuries ($n = 110$; 67.9%) and extremity injuries ($n = 103$; 63.5%) were the most common. These were followed by maxillofacial injuries ($n = 64$; 39.5%) and pneumothorax, hemopneumothorax, or pulmonary contusion ($n = 62$; 38.2%). Pelvic injuries were present in 18.5% of patients, rib fractures in 13.5%, and spinal injuries in 12.3%. Hepatic, splenic, or renal injuries were identified in 9.2% of patients, while gastrointestinal injuries and fractures of the clavicle, scapula, or sternum were each observed in 7.4%.

Comparison of HALP, CALLY, and PNI According to Survival Status

When the groups were compared in terms of the prognostic indices evaluated, the HALP score was lower in the non-survivor group; however, the difference between the groups was not statistically significant [1.9 (1.3 – 3.2) vs. 2.3 (1.6 – 3.5); $p = 0.605$]. In contrast, the CALLY index was significantly lower in non-survivors than in survivors [1.1 (0.3 – 4.9) vs. 3.4 (0.9 – 11.8); $p = 0.036$]. Similarly, PNI was markedly lower in the non-survivor group [31.0 (21.0 – 37.0) vs. 38.0 (33.0 – 42.0); $p = 0.001$].

Multivariable Analysis of Factors Associated with In-Hospital Mortality

To evaluate the independent associations of HALP, CALLY, and PNI with in-hospital mortality, each index was analyzed in a separate Firth penalized logistic regression model adjusted for ISS and GCS, given that the indices share common laboratory components.

In Model 1, which included HALP, ISS was independently associated with increased odds of in-hospital mortality (adjusted OR = 1.195; 95% CI: 1.099–1.299; $p < 0.001$), whereas a higher GCS score was associated with lower odds of mortality (adjusted OR = 0.773; 95% CI: 0.653–0.914; $p = 0.003$). The HALP score was not independently associated with mortality after adjustment (adjusted OR = 0.959; 95% CI: 0.816–1.127; $p = 0.611$). The discriminative performance of Model 1 was AUC = 0.916.

In Model 2, which included the CALLY index, ISS (adjusted OR = 1.202; 95% CI: 1.105–1.307; $p < 0.001$) and GCS (adjusted OR = 0.777; 95% CI: 0.658–0.916; $p = 0.003$) remained independently associated with mortality, whereas the independent association between the CALLY index and mortality did not reach statistical significance (adjusted OR = 0.966; 95% CI: 0.916–1.018; $p = 0.194$). The AUC for Model 2 was 0.924.

In Model 3, which included PNI, a higher ISS was independently associated with increased odds of in-hospital mortality (adjusted OR = 1.322; 95% CI: 1.159–1.508; $p < 0.001$). PNI remained independently associated with in-hospital mortality after adjustment for ISS and GCS (adjusted OR = 0.803; 95% CI: 0.704–0.916; $p = 0.001$). Accordingly, each one-unit increase in PNI was associated with an approximately 19.7% reduction in the odds of in-hospital mortality, with the other variables held constant. In this model, the association between GCS and mortality did not reach statistical significance (adjusted OR = 0.836; 95% CI: 0.695–1.006; $p = 0.059$). Among the three models, Model 3 had the numerically highest discriminative performance (AUC = 0.964).

Performance of HALP, CALLY, and PNI in Predicting In-Hospital Mortality

The standalone discriminative performance of HALP, CALLY, and PNI for in-hospital mortality was evaluated using receiver operating characteristic (ROC) curve analysis. For HALP, the AUC was 0.537 (95% CI: 0.396–0.677). At a cutoff value of ≤ 2.03 , HALP had a sensitivity of 57.9% and a specificity of 61.5%. For the CALLY index, the AUC was 0.648 (95% CI: 0.507–0.789), with a sensitivity of 47.4% and a specificity of 83.9% at a cutoff value of ≤ 0.55 .

Among the three indices, PNI had the numerically highest AUC (AUC = 0.740; 95% CI: 0.607–0.873). At a cutoff value of ≤ 40.0 , PNI had a sensitivity of 85.7% and a specificity of 35.7%. Thus, in standalone ROC analysis, PNI showed the numerically highest discriminative performance among the three indices evaluated, whereas CALLY showed moderate discrimination and HALP showed limited discrimination.

Discussion

In this retrospective cohort study, we evaluated the associations of the HALP score, CALLY index, and PNI with in-hospital mortality and their prognostic performance in patients with polytrauma admitted to the ICU. The principal finding of our study was that PNI was significantly lower in patients who died and that this association persisted after adjustment for ISS and GCS, which reflect injury severity and neurological status, respectively. Each one-unit increase in PNI was associated with an approximately 20% reduction in the odds of in-hospital mortality. Furthermore, among the three indices evaluated, PNI had the numerically highest AUC for discriminating in-hospital mortality when assessed as a standalone predictor (AUC = 0.740). Although the CALLY index was significantly lower in the non-survivor group, it did not retain an independent association with mortality in multivariable analysis. In contrast, the HALP score showed no significant association with mortality either in the between-group comparison or after adjustment for potential confounders. These findings suggest that baseline immunonutritional status

may be associated with prognosis in critically ill patients with polytrauma and that PNI, in particular, may provide prognostic information independent of injury severity.

PNI is an easily calculated index that combines serum albumin levels and peripheral lymphocyte counts, thereby providing integrated information on a patient's nutritional and immunological status [16]. Because the systemic inflammatory and catabolic responses triggered by critical illness and major trauma may lead to reductions in albumin and lymphocyte levels through increased capillary permeability, alterations in protein metabolism, and immune dysregulation, a low PNI may reflect not only reduced nutritional reserve but also the inflammatory and immune burden of acute illness [17, 18]. Recent studies in critically ill populations have demonstrated that this pathophysiological relationship is also reflected in clinical outcomes, with lower PNI values being associated with increased mortality [5, 15–18]. Karagoz et al., in a retrospective study of critically ill patients, reported that PNI values were significantly lower in non-survivors than in survivors and that PNI was independently associated with mortality [16]. Similarly, a recent study of 1,457 critically ill patients using the MIMIC-IV database found that higher PNI values were independently associated with reduced risks of both 30-day and 90-day mortality [17]. However, data specific to trauma patients are not entirely consistent. In a study by Rau et al. involving 1,126 trauma patients admitted to the ICU, PNI was not identified as an independent predictor of mortality in multivariable analysis (OR = 0.99; 95% CI: 0.97–1.02; $p = 0.518$) [4]. In contrast, a systematic review and meta-analysis published in 2026, comprising 18 studies and a total of 11,275 trauma patients, showed that lower nutritional indices were associated with higher mortality, increased complication rates, and longer hospital stays; however, subgroup analyses indicated that the association between PNI and mortality was weaker than that observed with other nutritional assessment tools [19]. Furthermore, immunological and nutritional scores have been reported to be associated with short-term mortality and poor functional outcomes in patients with traumatic brain injury [20, 21]. Consistent with these findings, our observation that PNI was lower in patients who died and remained independently associated with in-hospital mortality even after adjustment for ISS and GCS suggests that PNI may provide additional prognostic information beyond anatomical injury severity and neurological status in critically ill patients with polytrauma.

The CALLY index is a novel prognostic marker that integrates CRP, albumin, and lymphocyte count into a single parameter, thereby simultaneously reflecting systemic inflammation, nutritional status, and immune response [22]. Given that CRP reflects the acute inflammatory response, albumin reflects changes associated with inflammation and nutritional reserve, and lymphocyte count reflects cellular immune function, low CALLY values are considered to represent a composite indicator of more pronounced inflammation, hypoalbuminemia, and immune dysfunction [23]. Although much of the initial evidence regarding the CALLY index was derived from patients with malignancies, its prognostic value has recently been investigated in acute conditions associated with a high risk of mortality, such as sepsis [14, 22, 23]. More recently, the prognostic value of the CALLY index has also been explored in trauma populations [24–26]. In a retrospective study involving 550 trauma patients admitted to the emergency department, patients with low CALLY values had higher rates of in-hospital mortality (25% vs. 8%) and ICU admission (45% vs. 18%), suggesting that the CALLY index may serve as a potential marker

for risk stratification in trauma patients [24]. Another study conducted in older patients with hip fractures demonstrated the prognostic value of the CALLY index for predicting 30-day mortality [25]. However, evidence also suggests that the incremental prognostic value of CALLY beyond established prognostic scores may be limited in trauma patients. In a retrospective study by Hsieh et al. involving 1,242 trauma patients admitted to the ICU of a Level I trauma center, adding the CALLY index to APACHE II increased the AUC only marginally, from 0.811 to 0.812. Moreover, the addition of CALLY did not improve the discriminative performance of the MPM II, MPM24 II, or MPM48 II models, nor did its addition to TRISS improve prognostic performance [26]. Consistent with these findings, although the CALLY index was significantly lower in patients who died in our study [1.1 (0.3–4.9) vs. 3.4 (0.9–11.8); $p = 0.036$], it did not remain independently associated with in-hospital mortality after adjustment for ISS and GCS (aOR = 0.966; 95% CI: 0.916–1.018; $p = 0.194$). Furthermore, the limited standalone discriminative performance of CALLY for in-hospital mortality (AUC = 0.648; 95% CI: 0.507–0.789) suggests that, although CALLY may reflect the inflammatory and immunonutritional burden in critically ill patients with polytrauma, the additional independent prognostic information it provides beyond established factors such as injury severity and neurological status may be limited.

The HALP score is an easily applicable prognostic indicator that integrates hemoglobin, albumin, lymphocyte, and platelet values into a single composite index, thereby aiming to reflect a patient's hematological, nutritional, and immune-inflammatory status [7, 10]. Although studies investigating the prognostic value of HALP in trauma patients have increased in recent years, a substantial proportion of the available evidence has been derived from geriatric populations with hip and proximal femur fractures [27–29]. Vural et al. reported that, among 435 older patients with proximal femur fractures, HALP scores were lower in patients who died and that, at a cutoff value of 17.975, HALP predicted 1-year mortality with an AUC of 0.826 (95% CI: 0.784–0.868), a sensitivity of 66%, and a specificity of 86.3% [27]. Similarly, in a large cohort study involving 1,707 older patients with hip fractures, higher HALP values were independently associated with reduced risks of both 90-day and long-term mortality, and the addition of HALP to existing prognostic models was shown to improve model performance [28]. Another study involving patients who underwent hemiarthroplasty for femoral neck fractures reported that a low HALP score was associated with 6-month mortality and that the AUC of HALP for mortality was 0.804 [29].

However, findings regarding the prognostic performance of HALP in trauma-related populations have not been entirely consistent. In a recent study evaluating 257 older patients admitted to the ICU after hip fracture, HALP values were lower among patients who died; nevertheless, HALP was not identified as an independent predictor of 1-year mortality in multivariable analysis, and its discriminative performance was limited (AUC = 0.648). In contrast, PNI remained independently associated with mortality [30]. Similarly, in another study involving 521 older patients with hip fractures, HALP was associated with mortality in univariable analysis but lost its independent prognostic value after multivariable adjustment [31]. These findings are consistent with the results of our study. HALP scores did not differ significantly between non-survivors and survivors with polytrauma ($p = 0.605$), showed poor standalone discrimination for in-hospital mortality (AUC = 0.537; 95% CI: 0.396–0.677), and were not independently

associated with in-hospital mortality after adjustment for ISS and GCS (aOR = 0.959; 95% CI: 0.816–1.127; $p = 0.611$).

Although HALP, CALLY, and PNI share immunonutritional components, they showed different prognostic patterns in our cohort. These differences may partly reflect the dynamic pathophysiology of acute trauma. Hemoglobin and platelet levels may be influenced by hemorrhage, coagulopathy, and early resuscitation, potentially affecting the prognostic performance of HALP, whereas the time-dependent kinetics of CRP may limit the prognostic value of CALLY when measured early after trauma [32 – 24]. As these mechanisms were not directly investigated in our study, they should be regarded as potential explanations requiring further investigation.

Limitations

This study has several limitations. First, its retrospective, single-center design may have increased the risk of selection bias and limits the generalizability of the findings to other trauma centers and patient populations. Second, the relatively small sample size and the occurrence of in-hospital mortality in only 19 patients limited the precision of the estimates, particularly in multivariable analyses, as well as the number of variables that could be included in the models. Although the indices were therefore evaluated in separate Firth penalized logistic regression models, the findings require validation in larger cohorts. Third, HALP, CALLY, and PNI were calculated only from the first eligible laboratory results obtained at hospital admission, and temporal changes in these indices during the ICU stay were not evaluated. In addition, individual differences in the interval between trauma and blood sampling, as well as the effects of early fluid resuscitation, blood product transfusion, and other therapeutic interventions on laboratory parameters, could not be fully standardized because of the retrospective design. These factors may have particularly affected HALP, which incorporates hemoglobin and platelet counts, and CALLY, which includes CRP, a marker sensitive to the acute inflammatory response. Fourth, although the multivariable models were adjusted for ISS and GCS, residual confounding from factors that were either unmeasured or not included in the models, such as comorbidities, injury patterns, severity of hemorrhagic shock, transfusion requirements, and treatment-related factors, cannot be excluded. Finally, the optimal cutoff values identified by ROC analysis were derived from the same study cohort and were not tested in an independent validation cohort. Therefore, particularly the PNI cutoff of ≤ 40 should be externally validated in larger and diverse polytrauma populations before being used for clinical decision-making.

Conclusion

In this study, PNI was independently associated with in-hospital mortality in critically ill patients with polytrauma, whereas the HALP score and CALLY index did not demonstrate independent prognostic value after adjustment for injury severity and neurological status. Among the three indices evaluated, PNI showed the numerically highest standalone discriminative performance for mortality. As PNI can be calculated from routinely available laboratory parameters, it may serve as a potential risk marker to complement existing clinical assessments in critically ill patients with polytrauma.

Abbreviations

HALP: Hemoglobin–albumin–lymphocyte–platelet, CALLY: C-reactive protein–albumin–lymphocyte, PNI: Prognostic nutritional index, ICU: Intensive care unit, ROC: Receiver operating characteristic, APACHE-II: Acute physiology and chronic health evaluation-II, GCS: Glasgow Coma Scale, IQR: interquartile range, AUC: Area under curve, ASA: American Society of Anesthesiologist, CRP: C-reactive protein, RTS: Revised Trauma Score, ISS: Injury Severity Score, AIS: Abbreviated Injury Scale

Declarations

We confirm that this article is original and has not been published elsewhere, nor is it currently under consideration for publication elsewhere. All authors have approved the manuscript for submission. The authors declare no conflict of interest. Plagiarism scanning was done with iThenticate. The manuscript has been checked in terms of language and grammar (Grammarly premium). Artificial intelligence-supported technologies (e.g., ChatGPT) were not used in writing the article.

Ethics approval and consent to participate

This single-center retrospective observational study was approved by the Institutional Review Board at University of Health Sciences, Istanbul Kanuni Sultan Süleyman Training and Research Hospital (approval number: KAEK/2026.01.25, January 28, 2026) and the need for written informed consent was waived.

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Consent for publication: Not Applicable

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare no conflicts of interest.

Authors' contributions

KA performed data analysis and drafted the manuscript. KA, AE, HÇA and ASS contributed to study design and critical revision of the manuscript. All authors read and approved the final manuscript.

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Tables

Tables 1 to 5 are available in the supplementary files section.

Figures

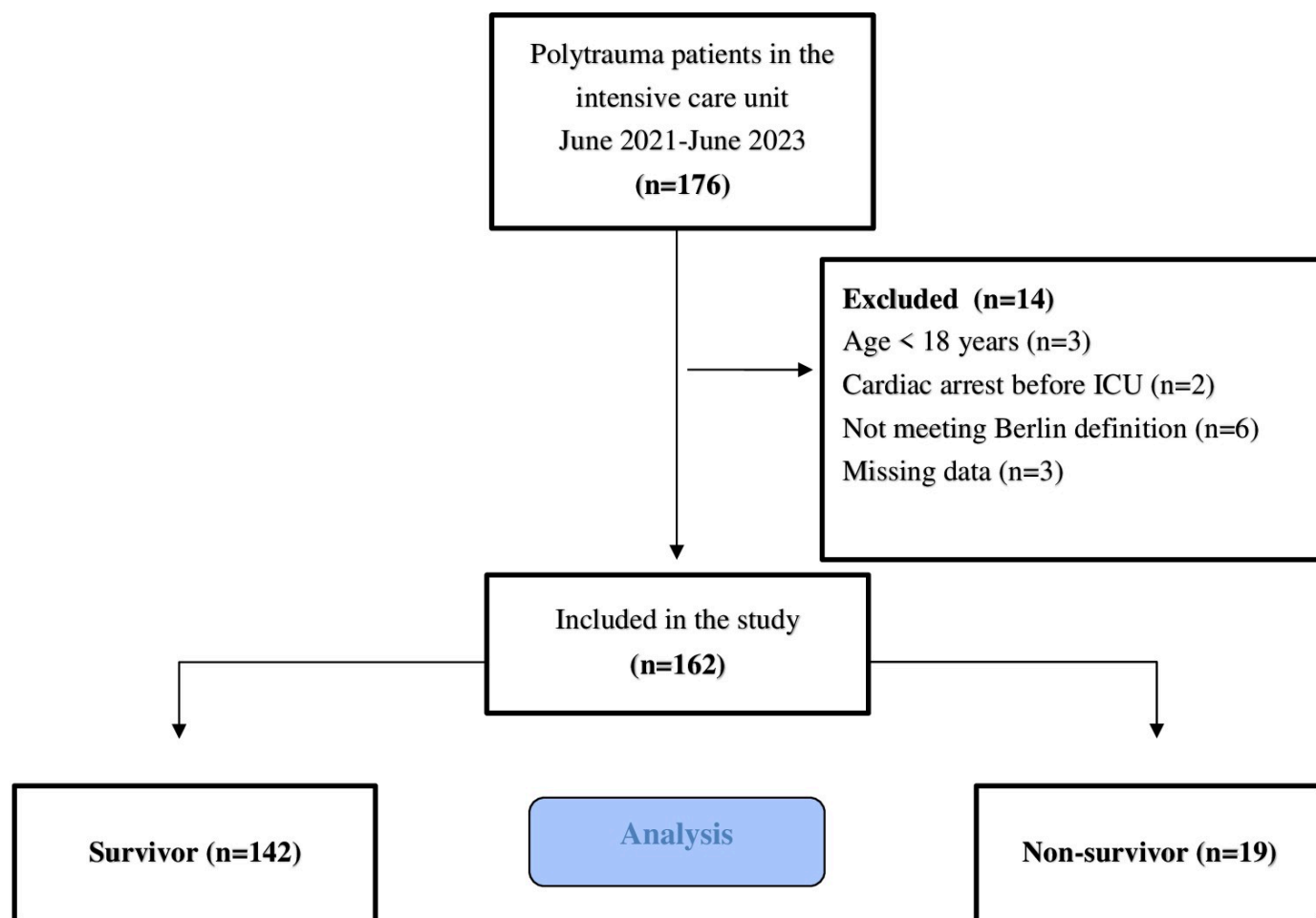


Figure 1

Legend not included with this version.

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