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ORIGINAL RESEARCH

Effects of HALP Score, C-Reactive Protein/Albumin Ratio, and Platelet/Lymphocyte Ratio on Predicting Mortality in Geriatric Patients in the Respiratory Intensive Care Unit

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Aim: This study aims to evaluate the effects of the hemoglobin, albumin, lymphocyte, and platelet (HALP) score, C-reactive protein/albumin ratio (CAR), and platelet/lymphocyte ratio (PLR) on predicting mortality in geriatric patients admitted to the respiratory intensive care unit (ICU).

Materials and Methods: In this retrospective observational cohort study, data of patients followed up in the respiratory ICU between 01.07.2021 and 31.12.2023 were evaluated. Age, gender, HALP score, hemoglobin, albumin, lymphocyte, platelet, and C-reactive protein (CRP) levels, along with PLR, CAR, and patient prognosis (exitus/discharge), were recorded from patient files and the hospital data processing system.

Results: The study included 405 patients (140 women and 265 men) over 65 years of age. In multivariate analysis, higher PLR and CAR values were associated with a higher mortality rate, whereas patients with a higher HALP score had a lower mortality rate ($p<0.001$). In the ROC analysis, a statistically significant cut-off value was found for the HALP score in predicting mortality ($p<0.001$). HALP score ≤ 9.94 indicates mortality, with a sensitivity of 67.25%, specificity of 53%, PPV (positive predictive value) of 64.98%, and NPV (negative predictive value) of 55%. CAR value ≥ 30.13 indicates mortality, with a sensitivity of 69.87%, specificity of 61.36%, PPV of 70.18% and NPV of 61.02%. There was no statistically significant cut-off value for PLR in predicting mortality ($p=0.076$).

Conclusion: We found that the HALP score, PLR value, and CAR value are important scores that may be useful in determining mortality and treatment modality in geriatric patients treated in the ICU.

Keywords: HALP score, CRP/albumin ratio, platelet/lymphocyte ratio, geriatric patients, intensive care units

Introduction

The proportion of geriatric patients in intensive care units (ICUs) is gradually increasing due to declining birth rates, advances in medical science, and the rise in both life expectancy and quality of life worldwide.[1] According to the World Health Organization (WHO), old age as a calendar age is defined as follows: Young old: 60–64, old old: 65–74, elderly: 75–84, very old: 85 and above.[2]

Existing diseases, advanced age, malnutrition, and infection are important factors that affect survival in the ICU. Geriatric patients have many comorbidities that increase mortality.[3] The incidence of sepsis increases with age, and patients over 65 years of age have high mortality rates.[4]

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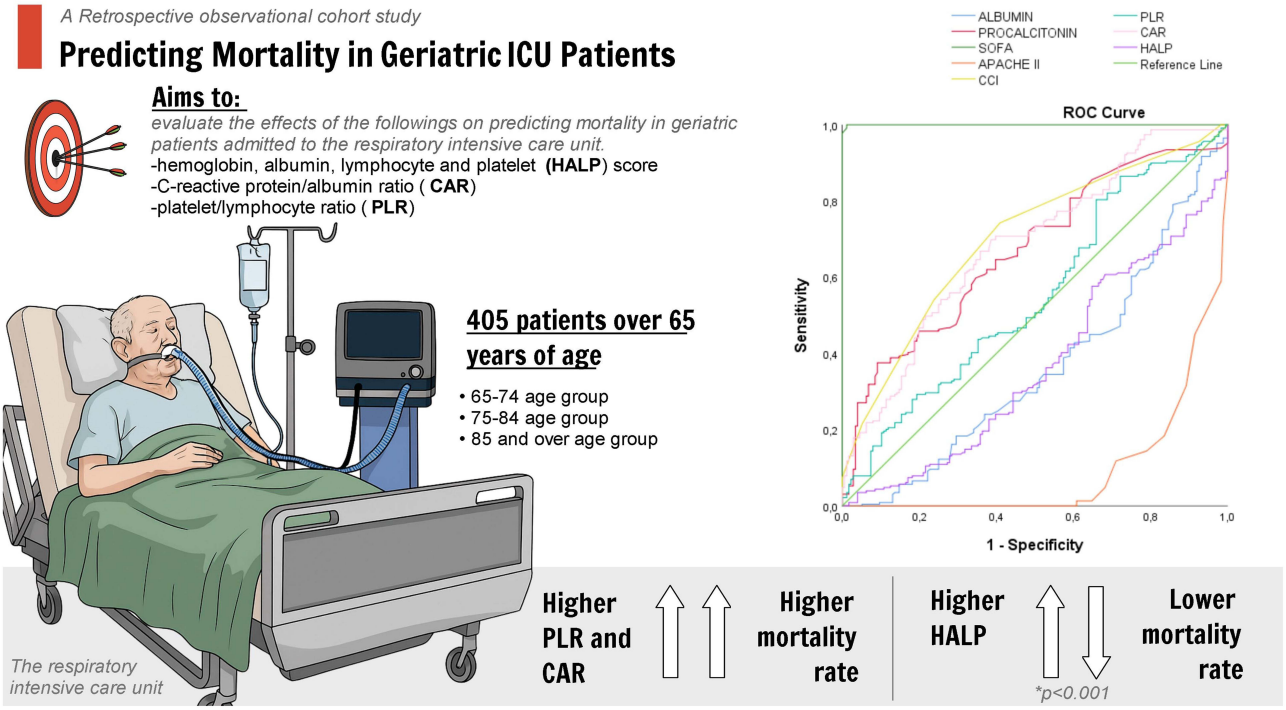
Graphical Abstract



Age may increase existing comorbidity and organ dysfunction, but its impact on ICU admission and mortality is still unclear. Although there are no epidemiologic studies, it is known that the number of elderly patients in ICUs is increasing day by day. In many studies, it has been suggested that the classification of elderly patients should not be based only on age; scoring systems should be applied, and treatment should be directed accordingly.[5]

The hemoglobin, albumin, lymphocyte, and platelet score (HALP score) is a current scoring system of diagnostic and prognostic value. This score reveals systemic inflammation and nutritional status and is easy to calculate. HALP score calculation formula: hemoglobin level (g/L) × albumin level (g/L) × lymphocyte count (10^9/L)/platelet count (10^9/L).[6]

Platelet-lymphocyte ratio (PLR) is a combination of two indices related to platelet aggregation and inflammatory process. It is a ratio that can be easily calculated in the clinical particle.[7]

C-reactive protein is an acute-phase reactant and a marker of acute and chronic inflammation. Albumin is an indicator of malnutrition, and hypoalbuminemia is a prognostic factor in hospitalized elderly patients. CRP/Albumin ratio (CAR) has recently been tested as a prognostic marker in many studies.[8]

We aimed to investigate the effects of the HALP score, CAR, and PLR values on predicting mortality in geriatric patients in the respiratory ICU.

Materials and Methods

Study Design and Patients

This retrospective observational cohort study was conducted using data from patients followed in the respiratory ICU between 01.07.2021 and 31.12.2023. Ethics committee approval (Decision no: 337) was obtained for the study at Health Sciences University Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital. The study was conducted in accordance with the Declaration of Helsinki. Due to the retrospective nature of the study, the requirement for informed consent was waived and the waiver was approved by the Ethics Committee of the University of Health Sciences Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital. All patient data were handled in

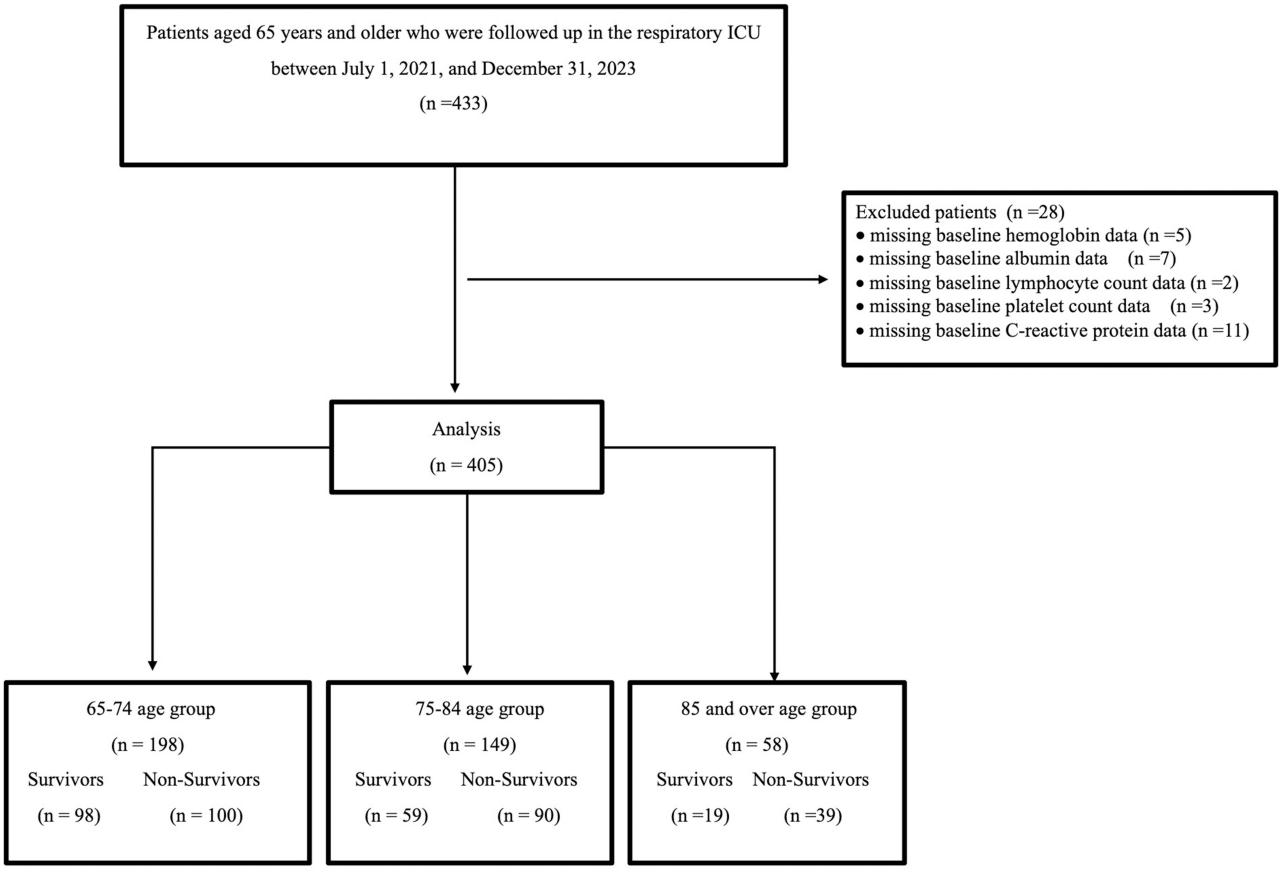


Figure 1 Study flow chart.

strict adherence to ethical standards, ensuring confidentiality and anonymity. No personal identifiers were used in the analysis or reporting of study results. Patients over 65 years of age with complete data were included in the study. Patients aged below 65 years and patients with incomplete data were excluded. Patients were divided into three groups according to age: 65–74 years, 75–84 years, and 85 years and older. The study design is illustrated in Figure 1.

Data Collection and Definition

Patients' age, gender, length of stay in the ICU, Glasgow coma scale (GCS), Charlson comorbidity index (CCI), Acute Physiology and Chronic Health Evaluation II (APACHE II), Sequential Organ Failure Assessment (SOFA), HALP score and patient prognosis (exitus/discharge) were recorded.

Hemoglobin, albumin, lymphocyte, platelet, C-reactive protein (CRP), procalcitonin values, platelet/lymphocyte ratio, and CRP/Albumin ratio (CAR) at the time of ICU admission were recorded from patient files and the hospital data processing system.

Statistical Analysis

Data were analyzed using IBM SPSS V23. Cox Regression Analysis was used to analyze the risk factors for death in all patients and in each age group. ROC Analysis was used to determine the cut-off value for the parameters. Analysis results were presented as frequency (percentage) for categorical variables and mean ± standard deviation for quantitative variables. The comparison of intensive care unit length of stay according to survival status in each age group and in all patients was performed using the Mann–Whitney *U*-test. The significance level was taken as $p<0.05$.

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Results

The study included a total of 405 patients, of whom 140 were female. A total of 229 patients died. Analysis of scores and parameters predicting mortality in all patients revealed that advanced age was associated with a higher mortality rate (p<0.001). The mortality rate was found to be lower in females compared to males. Higher hemoglobin levels were associated with lower mortality rates, whereas higher procalcitonin levels were associated with higher mortality rates. Elevated SOFA and APACHE II scores were associated with higher mortality rates, while higher GCS scores were associated with lower mortality rates. Similarly, an increased CCI score was linked to higher mortality rates (p<0.001). Additionally, higher PLR and CAR levels were associated with increased mortality, whereas a higher HALP score was associated with lower mortality rates (p<0.001) (Table 1).

When comparing hospital length of stay across different age groups, the median duration of hospitalization for patients aged 65–74 years who were discharged is 12 days, whereas for those who deceased, the median length of stay is 22 days. A statistically significant difference was noted in the median hospitalization duration for discharged patients in the 65–74 age group (p=0.007). However, no significant difference was observed in the median hospitalization duration for patients aged 75–84 years and those 85 years and older (p>0.050). Overall, the median hospitalization duration for all discharged patients was 12 days, compared to 19 days for deceased patients. A statistically significant difference was found between the median hospitalization durations of discharged and deceased patients across all age groups (p<0.001) (Table 2).

There were 198 patients aged 65–74 years, 71 of whom were women. When the factors affecting mortality in this age group were analyzed universally, gender, PLR and HALP scores were not significant (p>0.05). In multivariate analysis, gender, procalcitonin, GCS, CCI, and CAR were not significant (p>0.05) (Table 3).

There were 149 patients, 47 of whom were women aged 75–84 years. When the factors affecting mortality in this age group were analyzed univariately, hemoglobin, CCI, and HALP scores were not significant (p>0.05). In multivariate analysis, gender, hemoglobin, GCS, CCI, and CAR were not significant (p>0.05) (Table 3).

There were 58 patients, 22 of whom were women, in the 85 and older age group. When the factors affecting mortality in this age group were analyzed univariately, only the SOFA score was found to be significant (p<0.001). In multivariate analysis, no variable was found significant (p>0.05) (Table 3).

In the ROC analysis for the factors affecting mortality, cut-off values were found for all parameters except the PLR value (Table 4). Since the values for PLR were not statistically significant, the analysis was discontinued.

ROC curves for Albumin, Procalcitonin, SOFA, APACHE II, CCI, PLR, CAR, and the HALP score are shown (Figure 2).

Table 1 Cox Regression Analysis Results of Factors Affecting Mortality in All Age Groups

	Survivors	Non-Survivors	Total	Univariate		Multivariate	
				HR (%95 CI)	p	HR (%95 CI)	p
Age (years)	74.32 ± 7.7	76.38 ± 7.56	75.48 ± 7.68	1.018 (1–1.035)	0.046	1.006 (0.985–1.027)	0.602
Gender							
Male n (%)	99 (37.4)	166 (62.6)	265 (100)	Reference			
Female n (%)	77 (55)	63 (45)	140 (100)	0.695 (0.52–0.93)	0.014	0.803 (0.595–1.082)	0.149
Hemoglobin (g/dl)†	10.36 ± 1.53	8.99 ± 1.89	9.58 ± 1.87	0.882 (0.818–0.951)	0.001	0.913 (0.84–0.991)	0.030
Procalcitonin (ng/mL)†	1.89 ± 8.35	6.12 ± 16.49	4.28 ± 13.72	1.023 (1.015–1.031)	<0.001	1.014 (1.003–1.026)	0.013
SOFA score†	5.28 ± 2.68	10.35 ± 2.87	8.15 ± 3.75	1.041 (1.033–1.05)	<0.001	1.028 (1.015–1.042)	<0.001
APACHE II score†	19.86 ± 6.89	32.5 ± 11.25	27.01 ± 11.46	1.088 (1.008–1.216)	<0.001	1.008 (1.002–1.154)	<0.001
GCS†	9.89 ± 3.04	7.15 ± 2.99	8.34 ± 3.3	0.877 (0.84–0.916)	<0.001	0.963 (0.909–1.021)	0.203
CCI†	6.45 ± 1.58	7.78 ± 1.92	7.2 ± 1.9	1.139 (1.067–1.217)	<0.001	1.004 (0.924–1.091)	0.919
PLR†	373.02 ± 280.64	440.45 ± 347.07	411.15 ± 321.27	1 (1–1.001)	0.016	1.001 (1–1.001)	<0.001
CAR†	30.45 ± 27.24	53.47 ± 42.16	43.47 ± 38.14	1.006 (1.002–1.009)	<0.001	1.001 (0.997–1.005)	0.601
HALP score†	16.45 ± 23.01	10.58 ± 12.06	13.13 ± 17.89	0.996 (0.983–1.009)	0.575	1.016 (1.007–1.025)	<0.001

Note: †mean± SD, p< 0.05 was considered statistically significant.

Abbreviations: SOFA, Sequential Organ Failure Assessment; APACHE II, Acute Physiology and Chronic Health Evaluation II; GCS, Glasgow Coma Scale; CCI, Charlson comorbidity index; PLR, Platelet/Lymphocyte ratio; CRP, C-reactive protein; CAR, CRP/Albumin ratio; HALP, hemoglobin (g/L) × albumin (g/L) × lymphocyte (10^9/L) / platelet (10^9/L); n, Number of patients; %, Percentage; HR, Hazard ratio; 95% CI, 95% Confidence interval.

Table 2 Comparison of Intensive Care Unit Length of Stay According to Survival Status in Each Age Group and in All Patients

Age Group	Prognosis	Mean ± SS	Median (min-max)	Test Statistic	p†
65–74 age	Survivors Non-Survivors	17.03 ± 16.14 24.63 ± 20.9	12 (0–97) 22 (0.03–108)	5.993	0.007
75–84 age	Survivors Non-Survivors	22.15 ± 24.2 22.93 ± 17.73	12 (1–97) 19 (0.03–64)	3.072	0.105
85 and over age	Survivors Non-Survivors	16.68 ± 20.69 23.08 ± 18.8	9 (1–94) 18 (2–84)	471.5	0.094
All patients	Survivors Non-Survivors	18.71 ± 19.71 23.70 ± 19.29	12 (0–97) 19 (03–108)	24,284.5	<0.001

Note: †Mann-Whitney U Test. p< 0.05 was considered statistically significant.
Abbreviations: SS, Standard deviation; min, minimum; max, maximum.

Table 3 Cox Regression Analysis Results of Factors Affecting Mortality in 65–74 years, 75–84 years and 85 and Over Age Group

	Survivors	Non-Survivors	Total	Univariate		Multivariate	
				HR (%95 CI)	p	HR (%95 CI)	p
65–74 age group Gender							
Male n (%)	56 (44.1)	71 (55.9)	127 (100)	Reference			
Female n (%)	42 (59.2)	29 (40.8)	71 (100)	0.736 (0.477–1.137)	0.167	0.677 (0.41–1.116)	0.126
Hemoglobin (g/dl)†	10.26 ± 1.48	8.96 ± 2.11	9.6 ± 1.93	0.741 (0.652–0.843)	<0.001	0.764 (0.655–0.891)	0.001
Procalcitonin (ng/mL)†	1.54 ± 8.24	4.64 ± 11.15	3.11 ± 9.91	1.022 (1.007–1.038)	0.004	1.003 (0.984–1.023)	0.745
SOFA score†	5.27 ± 2.64	10.03 ± 2.78	7.56 ± 3.58	1.040 (1.028–1.053)	<0.001	1.029 (1.006–1.051)	0.012
APACHE II score†	19.38 ± 6.67	32.32 ± 11.67	25.4 ± 11.18	1.005 (1.001–1.127)	<0.001	1.007 (1.005–1.163)	0.002
GKS†	9.69 ± 2.99	7.16 ± 3	8.41 ± 3.25	0.876 (0.818–0.939)	<0.001	0.934 (0.844–1.032)	0.180
CCI†	6.09 ± 1.53	6.96 ± 1.66	6.53 ± 1.65	1.231 (1.093–1.387)	0.001	1.136 (0.997–1.295)	0.056
PLR†	348.4 ± 278.22	402.41 ± 349.05	375.68 ± 316.35	1 (0.999–1.001)	0.842	1.001 (1–1.001)	0.041
CAR†	31.38 ± 27.19	60.31 ± 41.48	45.99 ± 37.93	1.007 (1.002–1.012)	0.003	1.002 (0.996–1.007)	0.576
HALP score†	19.66 ± 29.3	13.28 ± 15.98	16.44 ± 23.69	1.003 (0.991–1.014)	0.645	1.017 (1.006–1.027)	0.002
75–84 age group Gender							
Male n (%)	33 (32.4)	69 (67.6)	102 (100)	Reference			
Female n (%)	26 (55.3)	21 (44.7)	47 (100)	0.604 (0.37–0.986)	0.044	0.79 (0.471–1.324)	0.371
Hemoglobin (g/dl)†	10.47 ± 1.64	9.05 ± 1.74	9.61 ± 1.83	0.983 (0.877–1.102)	0.769	0.975 (0.844–1.127)	0.736
Procalcitonin (ng/mL)†	2.33 ± 8.87	8.02 ± 23.12	5.77 ± 18.98	1.025 (1.015–1.036)	<0.001	1.027 (1.008–1.046)	0.005
SOFA score†	5.25 ± 2.65	10.46 ± 2.85	8.4 ± 3.76	1.053 (1.037–1.068)	<0.001	1.038 (1.016–1.063)	0.001
APACHE II score†	20.12 ± 7.33	31.39 ± 10.15	26.93 ± 10.66	1.082 (1.036–1.293)	<0.001	1.022 (1.015–1.282)	0.012
GKS†	10.47 ± 3.06	7.29 ± 2.77	8.55 ± 3.28	0.859 (0.802–0.919)	<0.001	0.954 (0.874–1.042)	0.295
CCI†	6.63 ± 1.46	8.03 ± 1.77	7.48 ± 1.79	1.088 (0.969–1.222)	0.154	0.918 (0.808–1.044)	0.193
PLR†	440.79 ± 303.35	436.08 ± 314.52	437.95 ± 309.12	1.001 (1–1.002)	0.025	1.002 (1.001–1.003)	0.003
CAR†	27.96 ± 28.51	51.22 ± 45.72	42.01 ± 41.3	1.005 (1.001–1.009)	0.023	0.996 (0.989–1.003)	0.234
HALP score†	11.46 ± 9.1	9 ± 7.96	9.98 ± 8.49	0.985 (0.953–1.018)	0.374	1.056 (1.008–1.106)	0.021

(*Continued*)

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Table 3 (Continued).

	Survivors	Non-Survivors	Total	Univariate		Multivariate	
				HR (%95 CI)	p	HR (%95 CI)	p
85 and over age group							
Gender							
Male n (%)	10 (27.8)	26 (72.2)	36 (100)	Reference			
Female n (%)	9 (40.9)	13 (59.1)	22 (100)	0.812 (0.414–1.593)	0.545	0.675 (0.304–1.5)	0.335
Hemoglobin (g/dl)†	10.51 ± 1.45	8.92 ± 1.68	9.44 ± 1.77	0.997 (0.83–1.197)	0.970	1.1 (0.853–1.42)	0.462
Procalcitonin (ng/mL)†	2.29 ± 7.58	5.52 ± 6.43	4.46 ± 6.93	1.024 (0.979–1.071)	0.296	1.03 (0.96–1.106)	0.406
SOFA score†	5.47 ± 3.08	10.9 ± 3.09	9.12 ± 4.0	1.023 (1.003–1.043)	0.022	1.018 (0.984–1.053)	0.304
APACHE II score†	21.53 ± 6.61	35.54 ± 12.28	30.95 ± 12.58	1.184 (1.153–1.253)	0.059	1.085 (1.006–1.961)	0.132
GKS†	9.11 ± 3.05	6.79 ± 3.46	7.55 ± 3.48	0.951 (0.862–1.052)	0.321	1.98 (1.831–1.156)	0.811
CCI†	7.74 ± 1.52	9.31 ± 1.81	8.79 ± 1.86	1.126 (0.951–1.333)	0.169	1.001 (0.807–1.242)	0.994
PLR†	289.6 ± 162.34	548.09 ± 397.34	463.41 ± 358.54	1.001 (1–1.002)	0.154	1.001 (0.999–1.003)	0.205
CAR†	33.37 ± 24	41.15 ± 31.51	38.6 ± 29.28	0.998 (0.987–1.01)	0.765	0.991 (0.976–1.005)	0.212
HALP score†	15.39 ± 10.68	7.29 ± 4.82	9.94 ± 8.14	0.975 (0.92–1.034)	0.405	1.024 (0.917–1.143)	0.679

Note: †mean± SD. p< 0.05 was considered statistically significant.
Abbreviations: SOFA, Sequential Organ Failure Assessment; APACHE II, Acute Physiology and Chronic Health Evaluation II; GCS, Glasgow Coma Scale; CCI, Charlson comorbidity index; PLR, Platelet/Lymphocyte ratio; CRP, C-reactive protein; CAR, CRP/Albumin ratio; HALP, hemoglobin (g/L) × albumin (g/L) × lymphocyte (10^9/L) / platelet (10^9/L); n, Number of patients; %, Percentage; HR, Hazard ratio; 95% CI, 95% Confidence interval.

Table 4 ROC Analysis and Cut-off Values for Factors Affecting Mortality

	Cut Off	AUC (%95 CI)	p	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Albumin (g/L)	≤ 2.79	0.636 (0.581–0.69)	<0.001	52.84%	72.16%	71.18%	54.04%
Procalcitonin (ng/mL)	≥ 1.04	0.669 (0.617–0.721)	<0.001	37.55%	90.91%	84.31%	52.81%
SOFA score	≥ 12	1 (1–1)	<0.001	100.00%	98.86%	99.13%	100.00%
APACHE II score	≥12	0.907 (0.878–0.936)	<0.001	81.66%	83.52%	86.57%	77.78%
CCI	≥ 7	0.702 (0.651–0.753)	<0.001	74.24%	59.09%	70.25%	63.8%
PLR	–	0.551 (0.495–0.608)	0.076	–	–	–	–
CAR	≥ 30.13	0.684 (0.632–0.736)	<0.001	69.87%	61.36%	70.18%	61.02%
HALP score	≤ 9.94	0.631 (0.577–0.685)	<0.001	67.25%	52.84%	64.98%	55.36%

Note: p< 0.05 was considered statistically significant.
Abbreviations: SOFA, Sequential Organ Failure Assessment; APACHE II, Acute Physiology and Chronic Health Evaluation II; CCI, Charlson comorbidity index; PLR, Platelet/Lymphocyte ratio; CRP, C-reactive protein; CAR, CRP/Albumin ratio; HALP, hemoglobin (g/L) × albumin (g/L) × lymphocyte (10^9/L) / platelet (10^9/L); %, Percentage; AUC, area under the curve; PPV, positive predictive value; NPV, negative predictive value.

Discussion

HALP score is a newly defined prognostic marker for the mortality of patients. A higher HALP score is associated with longer survival. Low hemoglobin levels are common in ICU patients. Serum albumin level is used to assess nutritional status and protein synthesis. Lymphocytes play an important role in inflammation. High platelet counts cause thromboembolism and atherosclerotic lesions.[9–12] Ding et al found that a low HALP value was significantly associated with worse clinicopathologic features in patients with renal cell carcinoma.[13] A multicenter cohort study by Lijun et al revealed that low HALP scores increased the risk of cognitive impairment after stroke.[14] In a systematic review and meta-analysis of 13,110 patients by Hang et al, a low HALP score before treatment was found to be a reliable and negative prognostic biomarker for survival outcomes in cancer patients.[9] In a study conducted to predict the 28-day mortality in geriatric patients with acute ischemic stroke in the ICU, the HALP score was found to be statistically higher in surviving patients.[15] In our study, the HALP score was also found to be statistically higher in surviving patients compared to those who died. We believe it can be practically used to predict mortality in geriatric age groups in ICUs.

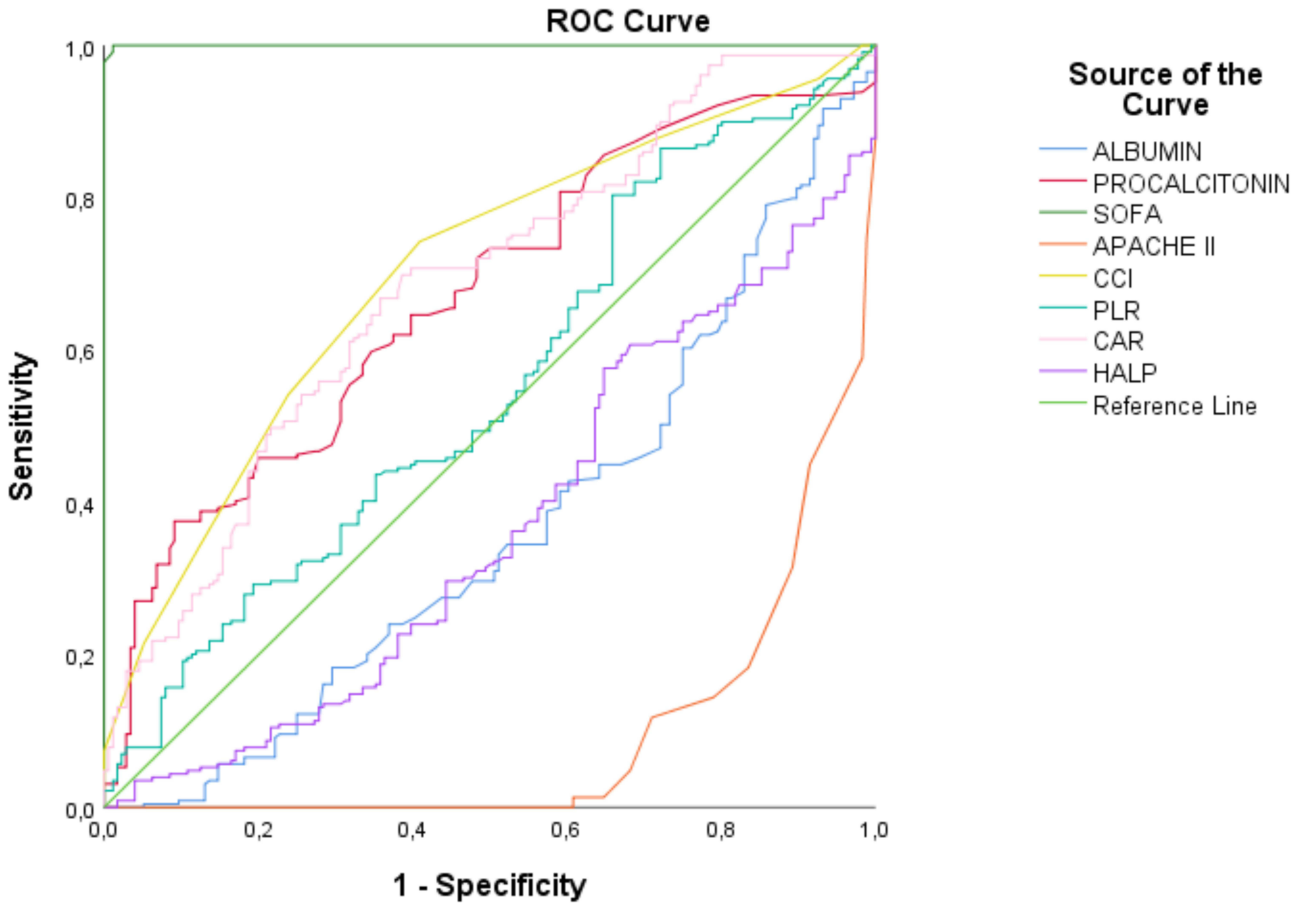

Figure 2 ROC Curve of Factors Affecting Mortality.

Albumin value, which is an important marker of malnutrition and susceptibility to sepsis, was found to be 2.74 ± 0.55 g/dl in deceased patients and 3.13 ± 0.55 g/dl in discharged patients in one study. In the same study, the CRP value was 65.16 ± 95.42 mg/L, while it was 41.16 ± 71.81 mg/L in the discharged patients.[16] Gabriella et al demonstrated prognostic value and good predictive accuracy when all biomarkers cut-off points of CRP ≥6.7 mg/L and CAR ≥2.0 were used as optimal cut-off points in a palliative center with terminal cancer patients. CAR offered the highest discrimination power.[8] In another study by Mustafa et al, the CAR value in geriatric age groups 65–75, 75–84, and 85 and above was statistically significant in all age groups in deceased and discharged patients.[17] In the study conducted by Guler et al in the respiratory ICU, the mean CAR value of deceased patients was 27.15, while that of discharged patients was 14.92 and statistically significant.[16] In the study by Yanhong et al, in patients who had a stroke, those who died within 30 days had a higher CAR than those who survived.[18] Similarly, in our study, when all age groups were evaluated together, the CAR value was 53.47 ± 42.16 in patients who died and 30.45 ± 27.24 in patients who were discharged. This shows that we can use CAR in mortality prediction. However, there was no statistical difference in the CAR value for mortality in the patient group aged 85 and over.

PLR is recognized as a novel marker in many systemic inflammatory diseases.[7] PLR is an indicator of the body's immune response to various stress stimuli and is valuable as a prognostic indicator in many diseases, including community-acquired pneumonia, malignancies, and myocardial infarction.[7,8,10,19,20] Bıyıklı et al did not find a significant relationship between PLR and mortality in their study of patients with sepsis.[19] Salih et al also found no statistical difference between PLR value and mortality in their study.[10] Colakoglu et al found no prognostic value of PLR value for mortality in patients undergoing acute abdominal surgery.[21] Yao et al showed that PLR value was a significant marker for mortality in chronic obstructive pulmonary disease.[20] Altaş et al showed that high PLR was associated with mortality in patients hospitalized in ICU with

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a diagnosis of pneumonia.[22] Similarly, in our study, although a high PLR value showed a significant difference in mortality, it did not show a statistical difference in mortality in patients over 85 years of age.

In our study, although the AUC values obtained for the HALP score and CAR were statistically significant, they indicate only a moderate level of diagnostic accuracy.[23,24] Prospective validation studies involving larger and more diverse patient populations are necessary to determine the clinical utility of these biomarkers. We propose that they should be used as complementary indicators rather than definitive diagnostic tools.

Limitations

The most important limitations of this study are its retrospective nature, single-center, and insufficient patient heterogeneity because it was performed in a respiratory ICU.

Conclusion

We believe that, based on the findings obtained in our study, the HALP score, PLR value, and CAR value can be important scoring systems that may be useful in determining mortality and treatment modality in geriatric patients treated in the ICU. Multicenter and prospective studies are needed to confirm these findings.

Abbreviations

SOFA, Sequential Organ Failure Assessment; APACHE II, Acute Physiology and Chronic Health Evaluation II; GCS, Glasgow Coma Scale; CCI, Charlson comorbidity index; PLR, Platelet/Lymphocyte ratio; CRP, C-reactive protein; CAR, CRP/Albumin ratio; HALP, hemoglobin (g/L) × albumin (g/L) × lymphocyte (10^9/L) / platelet (10^9/L); n, Number of patients; %, Percentage; HR, Hazard ratio; 95% CI, 95% Confidence interval; $p< 0.05$ was considered statistically significant; AUC, area under the curve; PPV, positive predictive value; NPV, negative predictive value; SS, Standard deviation; min, minimum; max, maximum.

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics Statement

The study was conducted in accordance with the Declaration of Helsinki and ethics committee approval (Decision no: 337) was obtained from Health Sciences University Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital. Due to the retrospective nature of the study, the requirement for informed consent was waived and the waiver was approved by the Ethics Committee of Health Sciences University Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital. All patient data were handled in strict adherence to ethical standards, ensuring confidentiality and anonymity. No personal identifiers were used in the analysis or reporting of study results.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors declare that they have no competing interests in this work.

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