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ORIGINAL RESEARCH

Neutrophil Albumin Ratio is Associated with All-Cause Mortality in Stroke Patients: A Retrospective Database Study

Zhibo Chen[1]
Dewei Xie[1]
Yun Li[1]
Zebin Dai[2]
Saina Xiang[2]
Zhiyuan Chen[2]
Weiqian Zhu[1]

[1]Department of Neurology, The First Affiliated Hospital of Wenzhou Medical University, Wenzhou, Zhejiang Province, People's Republic of China; [2]College of the First Clinical Medical Sciences of Wenzhou Medical University, Wenzhou, Zhejiang, People's Republic of China

Objective: The novel biomarker, neutrophil percentage-to-albumin ratio (NPAR), as a prognostic tool for inflammation in relation to all-cause mortality for patients afflicted by strokes has yet to be explored.

Methods: Data sets associated with patient files stored within the MIMIC-III V1.4 database were obtained. Data files from 940-patients were obtained for this retrospective analysis. Clinical endpoints were determined to represent a month (30-), three months (90-) and year (365-) all-cause mortality in stroke patients were determined. In order to determine NPAR and clinical endpoint relationships, Cox proportional hazards models were utilized.

Results: For all-cause mortality within a 30-day period, in an unadjusted model, the HR (95% CIs) in group B (NPAR 20.5–25.0) and C (NPAR >25.0) was 1.17 (0.85, 1.63) and 1.55 (1.13, 2.11) compared with group A (NPAR < 20.5). Proceeding adjustment for more confounding factors, higher NPAR still obtained significant predictive power for 30-day all-cause mortality (HR= 1.45, 95% CI: 1.05, 2.00). Statistical significance (P = 0.0196) was also observed for the other time-based subgroupings for all-cause mortality.

Conclusion: A strong correlation was present between increased levels of the novel biomarker NPAR and increased risk of mortality in stroke patients.

Keywords: neutrophil-albumin ratio, mortality, stroke, biomarker

Introduction

Stroke is reported to be the leading lethal disease in People's Republic of China, which is also the principal cause of disability among adults.[1,2] Ischemic stroke accounts for 80% of all kinds of stroke.[3] Stroke may affect the first stroke patients again at a specific time point after rehabilitation in hospital.[4] Among patients in intensive care unit, critical stroke is very common.[5] However, the treatment outcomes are not satisfied for stroke patients, which brings their family and society great burden and economic loss.[3] Therefore, it is urgent to find a predicting biomarker of the prognosis of patients who are in an early stage of stroke.

The pathogenesis of stroke is closely related to inflammation, and the pathological processes involved in the development of acute ischemic stroke include endothelial activation, blood-brain barrier impairment, secretion of multiple inflammatory mediators, oxidants, and cytokines, and infiltration of platelet and leukocytes.[6,7]

Correspondence: Weiqian Zhu
Department of Neurology, The First Affiliated Hospital of Wenzhou Medical University, Wenzhou, 325000, Zhejiang Province, People's Republic of China
Tel +86 577 55579372
Fax +86 577 55579318
Email zhuwqfyxy@aliyun.com

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NPAR (neutrophil percentage-to-albumin ratio) was a newly reported inflammatory biomarker.[8] The prognostic and predictive functions of NPAR were found in various diseases, such as cardiovascular disease.[9] It was reported that reduced Albumin levels were closely correlated with worse outcomes of patients who had stroke.[10] Neutrophils play crucial roles in the innate cellular immune system.[11] Previous studies suggested that early higher neutrophil counts were correlated with increased stroke severity.[12] Nevertheless, to our knowledge, no previous study has focused on the NPAR. In this study, we hypothesized that NPAR is a novel biomarker of inflammation associated with all-cause Mortality in patients with stroke.

Therefore, in this study, the data from the latest MIMIC-III (Multiparameter Intelligent Monitoring in Intensive Care) database 18 were used to investigate the association between NPAR and outcomes of stroke. Various potential confounders were adjusted.

Methods

Study Population

The protocol was approved by Massachusetts Institute of Technology and the Institutional Review Boards. The vital signs, medications, demographic information and other essential data of the patients admitted to intensive care unit (53,423 distinct admissions) from 2001 to 2012 in the Beth Israel Deaconess Medical Center (BIDMC, Boston) were collected, which were downloaded from MIMIC-III version 1.4.[13] Investigators had learned the "Data or Specimens Only Research" online course. All data accessed complies with relevant data protection and privacy regulations.

Population Selection Criteria

We enrolled stroke patients (over 16 years) first admitted to the hospital with hospital stay over one day. And the patients were excluded if they stayed in ICU less than 48 hours, or had no data on the NPAR within the first 24 hours of admission.

Study Variables and Outcomes

The data upon admission were recorded, including vital signs, laboratory parameters, demographics, and comorbidities, etc. Comorbidities included malignancy, AF (atrial fibrillation), liver disease, pneumonia, renal disease, respiratory failure, CAD (coronary artery disease), and CHF (congestive heart failure). Laboratory parameters were WBC (white blood cells), BUN (blood urea nitrogen), APTT (activated partial thromboplastin time), PT (prothrombin time), potassium, anion gap, hemoglobin, creatinine, glucose, lactate, chloride, bicarbonate, sodium, platelet, hematocrit, albumin, bilirubin, INR (international normalized ratio), and the percentage of neutrophil. SAPSII (simplified acute physiology scores II) and APSIII (acute physiology score III) scores were also calculated. Furthermore, MBP (mean blood pressure), heart rate, DBP (diastolic blood pressure), respiratory rate, SBP (systolic blood pressure), SPO2, temperature, ethnicity, gender, and age were also recorded.

The primary outcome was 30-day mortality rate in our study, and the secondary outcomes included 90-day and 1-year mortality rates. The patients were followed up for at least one year since admission. The date of death was based on Social Security Death Index records.

Statistical Analysis

Three subgroups were set up based on the NPAR. Continuous variables were expressed as mean± SD (standard deviation), and categorical data as percentage or frequency. $\chi 2$ tests and Kruskal–Wallis *H*-test were employed to compare differences in baseline features between subgroups of NPAR for categoric variables and continuous variables, respectively. And then, the COX regression was used to assess the association between NPAR and outcomes of stroke patients. There was no covariate adjustment in Model 1. Age, ethnicity and gender were adjusted in Model 2. Confounders, eg, age, gender, ethnicity, sodium, chloride, CHF (yes/no), CAD (yes/no), AF (yes/no), renal disease (yes/no), liver disease (yes/no), and COPD (yes/no) were adjusted in Model 3. The relationship between 30-day all-cause mortality and NPAR was analyzed to investigate if NPAR effects differed among different subgroups.

R (Version 3.6.1) was used in all the analyses. P values were two-sided. P values <0.05 was considered statistically significant.

Results

Subject Characteristics

In our study, 940 participants (≥16 years old) were included. There were 516 males and 424 females. The average age was 68.8 ± 14.7 years, and the average NPAR value 23.5 ± 4.2.

Characteristics of the samples related to NPAR are listed in Table 1. The subjects were categorized into 3 groups based on NPAR values: group A: NPAR < 20.5 (313); group B: NPAR 20.5–25.0 (313); and group C: NPAR >25.0 (314). Compared with group A, participants in groups with higher NPAR (>25.0) showed lower SBP, bicarbonate, MBP, hematocrit, hemoglobin, and DBP, and had higher levels of creatinine, BUN, potassium, chloride, heart rate, respiratory rate, PT, APTT, INR, and increased the proportion of CHF, renal disease, pneumonia, respiratory failure, and mortality. In addition, tertiles were not significantly related to age, ethnicity and gender in our study population.

Association Between NAPR and Outcomes of Stroke Patients

Different models were used to assess independent effects of NAPR and the outcomes of stroke patients after other potential confounders were adjusted. Effect sizes (HR) and 95% CIs are shown in Table 2. For 30-day all-cause mortality, in an unadjusted model, the HR (95% CIs) in group B and C were 1.17 (0.85, 1.63) and 1.55 (1.13, 2.11), respectively, in comparison with group A. This association was significant after adjusting for age, gender, ethnicity, sodium, chloride, CHF, CAD, AF, renal disease, liver disease, COPD (HR= 1.45, 95% CI: 1.05, 2.00). The trend was also statistically significant (P = 0.0196). For 90-day all-cause mortality and 365-day all-cause mortality, a similar relationship was also observed.

Subgroup Analysis

Subgroup analysis was performed to investigate the relationship between 30-day all-cause mortality and NPAR (Table 3). No interaction was observed in most strata (P = 0.0650–0.9761). Only patients with WBC $<13.1*10^9$ /l had higher risks of all-cause mortality for high NPAR.

Discussion

To our knowledge, we first explored the correlations between NPAR and the mortality of stroke patients in the short term and long term. We found that higher NPAR was closely associated with increased all-cause mortality of stroke patients in the short or long term. Compared with the complex scoring systems, NPAR is easy to access and can help clinicians quickly make clinical strategies in time.

Strokes occur due to cerebral vascular occlusion or hemorrhage resulting in deprivation of oxygen and nutrients, causing a local inflammatory immune response.[14] This results in alteration of the systemic inflammatory response via the sympathetic pathway and the hypothalamus-pituitary-adrenal axis (poststroke immunosuppression) resulting in neutrophil demargination and stimulation of growth factors.[15,16] A positive correlation was observed within acute ischemic stroke patients, between total WBC-neutrophil counts proceeding 3 days of symptom onset severity and infarct volume.[17,18]

It has been suggested by prior studies, that the relationship between hypoproteinemia and stroke-related mortality, heart attack and fractures of the hip illustrate poorer disease prognosis with lower albumin values.[10,19,20] According to previous studies, albumin may exert neuroprotective function via its anti-inflammatory activity, antioxidant characteristics, inhibiting endothelial apoptosis, and regulating microvascular permeability.[21–23] Another theory is that low albumin in time of acute stroke could illustrate the role albumin's concentration plays during inflammation states as a negative acute phase reactant.[24] Negative regulation of the albumin synthesis may be controlled via interleukin (IL-6 and tumor necrosis factor, which are seen in increased concentrations during states of acute inflammation, such as acute stroke.[25] In this serum albumin repression a possible detrimental effect may interfere with albumin's antioxidative and endothelial effects.[26] Based on our results, the novel biomarker that is NPAR can be used to significantly predict stroke prognosis via neutrophil percentage and albumin levels.

Our study had some limitations. First, selection bias existed since this was a single-center retrospective study. Second, NPAR was only recorded when patients were admitted into the ICU and subsequent changes were not assessed. Third, other known and unknown factors still remain although we have made the best effort to control bias. In addition, the stroke severity score (National

Table 1 Characteristics of the Study Patients According to Neutrophil Percentage-to-Albumin Ratios

Characteristics	Neutrophil Percentage-to-Albumin Ratios			
	<20.5 (n = 313)	**≥20.5, <25.0 (n = 313)**	**≥25.0 (n = 314)**	***P* value**
Age, years	66.5 ± 14.8	67.2 ± 15.0	67.0 ± 14.2	0.839
Gender, n (%)				0.893
Female	139 (44.4)	140 (44.7)	145 (46.2)	
Male	174 (55.6)	173 (55.3)	169 (53.8)	
Ethnicity, n (%)				0.328
White	221 (70.6)	224 (71.6)	224 (71.3)	
Black	34 (10.9)	20 (6.4)	28 (8.9)	
Other	58 (18.5)	69 (22.0)	62 (19.7)	
NPAR	16.7 ± 4.2	22.6 ± 1.3	31.3 ± 7.1	<0.001
SBP, mmHg	130.5 ± 17.8	129.4 ± 17.5	121.4 ± 17.7	<0.001
DBP, mmHg	64.5 ± 11.1	64.8 ± 11.7	61.5 ± 11.0	<0.001
MBP, mmHg	83.5 ± 11.4	83.7 ± 12.0	79.3 ± 11.3	<0.001
Heart rate, beats/minute	80.4 ± 16.2	81.8 ± 14.5	87.6 ± 17.4	<0.001
Respiratory rate, beats/minute	18.4 ± 3.5	18.4 ± 3.4	20.3 ± 4.7	<0.001
Temperature, °C	36.9 ± 0.6	37.0 ± 0.6	36.9 ± 0.8	0.861
SPO2, %	97.5 ± 1.9	97.8 ± 2.1	97.5 ± 2.6	0.307
Comorbidities, n (%)				
Congestive heart failure	28 (8.9)	26 (8.3)	52 (16.6)	0.001
Coronary artery disease	43 (13.7)	64 (20.4)	56 (17.8)	0.082
Atrial fibrillation	84 (26.8)	90 (28.8)	108 (34.4)	0.100
Renal disease	27 (8.6)	35 (11.2)	64 (20.4)	<0.001
Liver disease	13 (4.2)	10 (3.2)	22 (7.0)	0.067
Pneumonia	72 (23.0)	84 (26.8)	126 (40.1)	<0.001
Malignancy	52 (16.6)	38 (12.1)	48 (15.3)	0.267
Respiratory failure	79 (25.2)	101 (32.3)	184 (58.6)	<0.001
COPD	1 (0.3)	3 (1.0)	4 (1.3)	0.416
Laboratory parameters				
Neutrophil percentage, %	66.9 ± 18.9	83.3 ± 7.5	85.4 ± 7.2	<0.001
Albumin, g/dl	4.0 ± 0.6	3.7 ± 0.4	2.8 ± 0.5	<0.001
Bicarbonate, mg/dl	25.8 ± 3.7	25.3 ± 3.5	24.3 ± 4.8	<0.001
Anion gap, mmol/l	16.8 ± 3.8	16.9 ± 3.8	17.5 ± 5.1	0.110
Creatinine, mEq/l	1.4 ± 2.5	1.5 ± 1.8	2.0 ± 1.7	<0.001
Chloride, mmol/l	106.6 ± 6.1	107.2 ± 6.7	108.8 ± 7.4	<0.001
Glucose, mg/dl	178.5 ± 87.1	192.5 ± 81.9	196.7 ± 94.2	0.025
Hematocrit, %	38.3 ± 6.1	38.3 ± 5.3	35.2 ± 6.1	<0.001
Hemoglobin, g/dl	13.0 ± 2.1	13.0 ± 1.9	11.7 ± 2.2	<0.001
Platelet, 10^9 /l	246.3 ± 112.6	258.6 ± 105.3	250.6 ± 144.0	0.446
Sodium, mmol/l	141.5 ± 5.3	141.6 ± 5.4	141.5 ± 5.6	0.972
Potassium, mmol/l	4.4 ± 0.8	4.4 ± 0.8	4.7 ± 0.9	<0.001
BUN, mg/dl	24.1 ± 19.1	24.4 ± 16.7	38.5 ± 29.3	<0.001
WBC, 10^9 /l	13.9 ± 21.5	14.0 ± 6.1	15.9 ± 8.9	0.109
PT, second	15.9 ± 9.2	15.8 ± 9.1	20.0 ± 14.4	<0.001
APTT, second	35.4 ± 21.2	37.1 ± 26.4	50.2 ± 36.5	<0.001
INR	1.5 ± 1.2	1.5 ± 1.4	2.0 ± 1.9	<0.001

(*Continued*)

Table 1 (Continued).

Characteristics	Neutrophil Percentage-to-Albumin Ratios			
	<20.5 (n = 313)	**≥20.5, <25.0 (n = 313)**	**≥25.0 (n = 314)**	***P* value**
Scoring systems				
APSIII	42.9 ± 19.9	43.3 ± 20.0	57.9 ± 24.8	<0.001
SAPSII	35.9 ± 13.8	38.4 ± 13.1	46.4 ± 14.6	<0.001
30-day mortality, n (%)	67 (21.4)	77 (24.6)	100 (31.8)	0.009
90-day mortality, n (%)	78 (24.9)	92 (29.4)	125 (39.8)	<0.001
365-day mortality, n (%)	97 (31.0)	107 (34.2)	145 (46.2)	<0.001

Abbreviations: NPAR, neutrophil percentage-to-albumin ratio; SBP, systolic blood pressure; DBP, diastolic blood pressure; MBP, mean blood pressure; COPD, chronic obstructive pulmonary disease; BUN, blood urea nitrogen; WBC, white blood cell; PT, prothrombin time; APTT, activated partial thromboplastin time; INR, international normalized ratio; APSIII, acute physiology score III; SAPSII, simplified acute physiology score II.

Table 2 HRs (95% CIs) for All-Cause Mortality Across Groups of Neutrophil Percentage-to-Albumin Ratios

NAR	Non-Adjusted		Model I		Model II	
	HR (95% CIs)	***P* value**	**HR (95% CIs)**	***P* value**	**HR (95% CIs)**	***P* value**
30-day all-cause mortality						
Tertiles						
<20.5	1.0 (ref)		1.0 (ref)		1.0 (ref)	
≥20.5, <25.0	1.17 (0.85, 1.63)	0.3389	1.11 (0.80, 1.55)	0.5175	1.10 (0.79, 1.54)	0.5670
≥25.0	1.55 (1.13, 2.11)	0.0058	1.52 (1.11, 2.07)	0.0083	1.45 (1.05, 2.00)	0.0254
P trend	0.0044		0.0054		0.0196	
90-day all-cause mortality						
Tertiles						
<20.5	1.0 (ref)		1.0 (ref)		1.0 (ref)	
≥20.5, <25.0	1.21 (0.90, 1.64)	0.2102	1.16 (0.86, 1.57)	0.3421	1.15 (0.85, 1.56)	0.3719
≥25.0	1.71 (1.29, 2.26)	0.0002	1.67 (1.26, 2.22)	0.0004	1.60 (1.19, 2.15)	0.0020
P trend	0.0001		0.0002		0.0013	
365-day all-cause mortality						
Tertiles						
<20.5	1.0 (ref)		1.0 (ref)		1.0 (ref)	
≥20.5, <25.0	1.14 (0.87, 1.50)	0.3539	1.08 (0.82, 1.42)	0.5774	1.08 (0.81, 1.42)	0.6105
≥25.0	1.63 (1.26, 2.11)	0.0002	1.60 (1.24, 2.07)	0.0003	1.50 (1.15, 1.97)	0.0030
P trend	<0.0001		0.0001		0.0017	

Notes: Models were derived from Cox proportional hazards regression models. Non-adjusted model adjust for: none. Adjust I model adjust for: age, ethnicity and gender. Adjust II model adjust for: age, gender, ethnicity, sodium, chloride, congestive heart failure, coronary artery disease, atrial fibrillation, renal disease, liver disease, chronic obstructive pulmonary disease.
Abbreviations: HR, hazard ratio; CI, confidence interval.

Institute of Health stroke scale) was not included in our study, which might have some significance. Furthermore, there were inaccurate data in the database. Thus, the findings still require verification by multi-center prospective studies.

Conclusions

We demonstrated that higher NPAR was closely associated with increased all-cause mortality in stroke patients. Nevertheless, these findings need to be confirmed by large prospective multicenter studies.

Table 3 Subgroup Analysis of the Associations Between the Neutrophil Percentage-to-Albumin Ratios and 30-Day All-Cause Mortality

	No. of Patients	Neutrophil Percentage-to-Albumin Ratios			*P* for Interaction
		<20.5	≥20.5, <25.0	≥25.0	
Age, years					0.2351
<69.2	470	1.0 (ref)	1.71 (0.98, 2.97)	2.15 (1.28, 3.60)	
≥69.2	470	1.0 (ref)	0.84 (0.56, 1.27)	1.19 (0.81, 1.76)	
Gender					0.8199
Female	424	1.0 (ref)	1.26 (0.80, 2.00)	1.69 (1.10, 2.61)	
Male	516	1.0 (ref)	1.09 (0.69, 1.74)	1.39 (0.89, 2.17)	
Ethnicity					0.1416
White	669	1.0 (ref)	1.12 (0.76, 1.65)	1.47 (1.02, 2.13)	
Black	82	1.0 (ref)	4.60 (0.89, 23.72)	4.58 (0.95, 22.07)	
Other	189	1.0 (ref)	0.90 (0.47, 1.72)	1.34 (0.72, 2.51)	
SBP, mmHg					0.5523
<127	469	1.0 (ref)	1.13 (0.67, 1.88)	1.63 (1.04, 2.56)	
≥127	470	1.0 (ref)	1.21 (0.79, 1.86)	1.47 (0.94, 2.32)	
DBP, mmHg					0.1894
<63	469	1.0 (ref)	0.78 (0.48, 1.27)	1.30 (0.85, 1.98)	
≥63	470	1.0 (ref)	1.66 (1.05, 2.61)	1.85 (1.17, 2.93)	
MBP, mmHg					0.3216
<82	469	1.0 (ref)	0.89 (0.54, 1.47)	1.40 (0.91, 2.15)	
≥82	470	1.0 (ref)	1.45 (0.93, 2.24)	1.72 (1.09, 2.70)	
Respiratory rate, beats/minute					0.6852
<18	469	1.0 (ref)	1.34 (0.84, 2.12)	1.74 (1.08, 2.80)	
≥18	469	1.0 (ref)	1.00 (0.63, 1.59)	1.30 (0.86, 1.96)	
Temperature, °C					0.2201
<36.9	466	1.0 (ref)	1.57 (0.98, 2.51)	1.69 (1.08, 2.66)	
≥36.9	467	1.0 (ref)	0.89 (0.56, 1.40)	1.45 (0.94, 2.21)	
SPO2, %					0.3479
<98	469	1.0 (ref)	1.12 (0.66, 1.88)	1.67 (1.04, 2.70)	
≥98	470	1.0 (ref)	1.14 (0.75, 1.74)	1.38 (0.92, 2.07)	
Sodium, mmol/l					0.6897
<140	423	1.0 (ref)	1.42 (0.85, 2.38)	1.83 (1.11, 3.01)	
≥140	514	1.0 (ref)	1.02 (0.66, 1.57)	1.37 (0.92, 2.05)	
Potassium, mmol/l					0.4276
<4.3	427	1.0 (ref)	1.24 (0.76, 2.02)	2.09 (1.30, 3.37)	
≥4.3	510	1.0 (ref)	1.13 (0.73, 1.77)	1.26 (0.84, 1.90)	
Chloride, mmol/l					0.5696
<107	439	1.0 (ref)	1.05 (0.65, 1.69)	1.84 (1.17, 2.89)	
≥107	498	1.0 (ref)	1.29 (0.81, 2.04)	1.39 (0.90, 2.15)	
WBC, 10^9 /l					0.0215
<13.1	462	1.0 (ref)	1.57 (0.94, 2.64)	2.42 (1.47, 3.98)	
≥13.1	475	1.0 (ref)	0.85 (0.55, 1.30)	1.00 (0.67, 1.48)	

(*Continued*)

Table 3 (Continued).

	No. of Patients	Neutrophil Percentage-to-Albumin Ratios			*P* for Interaction
		<20.5	≥20.5, <25.0	≥25.0	
Platelet, 10^9 /l					0.4410
<239	463	1.0 (ref)	1.09 (0.68, 1.75)	1.59 (1.04, 2.43)	
≥239	474	1.0 (ref)	1.28 (0.80, 2.02)	1.52 (0.96, 2.40)	
Hematocrit, %					0.3502
<37.4	463	1.0 (ref)	0.98 (0.60, 1.62)	1.37 (0.89, 2.11)	
≥37.4	474	1.0 (ref)	1.35 (0.87, 2.10)	1.74 (1.09, 2.77)	
Hemoglobin, g/dl					0.9761
<12.6	454	1.0 (ref)	1.20 (0.73, 1.98)	1.49 (0.96, 2.32)	
≥12.6	483	1.0 (ref)	1.16 (0.75, 1.80)	1.61 (1.02, 2.55)	
Creatinine, mEq/l					0.0650
<1.1	446	1.0 (ref)	1.46 (0.87, 2.44)	2.17 (1.29, 3.65)	
≥1.1	491	1.0 (ref)	1.00 (0.65, 1.55)	1.15 (0.78, 1.69)	
BUN, mg/dl					0.1011
<24	440	1.0 (ref)	1.59 (0.98, 2.59)	1.90 (1.09, 3.32)	
≥24	497	1.0 (ref)	0.87 (0.56, 1.37)	1.14 (0.78, 1.68)	
Anion gap, mmol/l					0.5589
<16	362	1.0 (ref)	1.02 (0.53, 1.94)	1.35 (0.74, 2.47)	
≥16	574	1.0 (ref)	1.23 (0.84, 1.81)	1.64 (1.14, 2.36)	
Bicarbonate, mg/dl					0.5392
<25	398	1.0 (ref)	1.00 (0.62, 1.63)	1.17 (0.74, 1.84)	
≥25	538	1.0 (ref)	1.26 (0.80, 1.98)	1.83 (1.19, 2.82)	
Glucose, mg/dl					0.1462
<164	467	1.0 (ref)	0.94 (0.53, 1.65)	1.80 (1.10, 2.95)	
≥164	470	1.0 (ref)	1.16 (0.76, 1.75)	1.25 (0.84, 1.87)	
PT, second					0.5228
<14	456	1.0 (ref)	1.06 (0.65, 1.72)	1.24 (0.72, 2.15)	
≥14	471	1.0 (ref)	1.31 (0.83, 2.05)	1.49 (1.00, 2.22)	
APTT, second					0.5421
<30	461	1.0 (ref)	0.90 (0.56, 1.44)	1.09 (0.64, 1.85)	
≥30	464	1.0 (ref)	1.62 (1.01, 2.57)	1.77 (1.17, 2.68)	
INR					0.2899
<1.3	446	1.0 (ref)	0.89 (0.55, 1.44)	1.11 (0.64, 1.91)	
≥1.3	481	1.0 (ref)	1.51 (0.96, 2.38)	1.65 (1.10, 2.50)	
CHF					0.1365
No	834	1.0 (ref)	1.27 (0.91, 1.79)	1.73 (1.25, 2.41)	
Yes	106	1.0 (ref)	0.38 (0.10, 1.45)	0.71 (0.29, 1.77)	
AFIB					0.9222
No	658	1.0 (ref)	1.22 (0.82, 1.82)	1.54 (1.05, 2.26)	
Yes	282	1.0 (ref)	1.07 (0.60, 1.89)	1.49 (0.88, 2.51)	
CAD					0.0806
No	777	1.0 (ref)	1.37 (0.96, 1.95)	1.58 (1.12, 2.22)	
Yes	163	1.0 (ref)	0.53 (0.23, 1.23)	1.35 (0.66, 2.76)	

(*Continued*)

Table 3 (Continued).

	No. of Patients	Neutrophil Percentage-to-Albumin Ratios			*P* for Interaction
		<20.5	≥20.5, <25.0	≥25.0	
Malignancy					0.5813
No	802	1.0 (ref)	1.24 (0.87, 1.76)	1.54 (1.10, 2.17)	
Yes	138	1.0 (ref)	0.78 (0.31, 1.99)	1.56 (0.74, 3.30)	
Liver disease					0.0806
No	895	1.0 (ref)	1.10 (0.78, 1.54)	1.52 (1.10, 2.09)	
Yes	45	1.0 (ref)	4.28 (1.10, 16.67)	1.81 (0.49, 6.70)	
Renal disease					0.1191
No	814	1.0 (ref)	1.30 (0.91, 1.85)	1.69 (1.20, 2.39)	
Yes	126	1.0 (ref)	0.55 (0.23, 1.31)	0.74 (0.37, 1.50)	
Respiratory failure					0.7417
No	576	1.0 (ref)	1.07 (0.71, 1.61)	1.46 (0.95, 2.25)	
Yes	364	1.0 (ref)	1.30 (0.74, 2.27)	1.42 (0.86, 2.35)	
Pneumonia					0.0696
No	658	1.0 (ref)	1.42 (0.96, 2.09)	1.91 (1.31, 2.80)	
Yes	282	1.0 (ref)	0.68 (0.36, 1.27)	0.93 (0.55, 1.59)	
COPD					0.3686
No	932	1.0 (ref)	1.18 (0.85, 1.65)	1.55 (1.13, 2.12)	
Yes	8	1.0 (ref)	0.37 (0.02, 5.97)	0.77 (0.07, 8.58)	
SAPSII					0.3904
<38	437	1.0 (ref)	1.63 (0.91, 2.91)	1.32 (0.65, 2.71)	
≥38	503	1.0 (ref)	0.85 (0.57, 1.26)	0.99 (0.70, 1.42)	
APSIII					0.7695
<43	459	1.0 (ref)	1.39 (0.81, 2.37)	1.80 (1.01, 3.24)	
≥43	481	1.0 (ref)	1.08 (0.71, 1.63)	1.09 (0.75, 1.58)	

Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure; MBP, mean blood pressure; WBC, white blood cell; BUN, blood urea nitrogen; PT, prothrombin time; APTT, activated partial thromboplastin time; INR, international normalized ratio; CHF, congestive heart failure; AFIB, atrial fibrillation; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; SAPSII, simplified acute physiology scoreII.

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Disclosure

The authors report no conflicts of interest in this work.

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