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Original Article

Effect of lactate/albumin ratio on mortality in patients aged ≥ 65 years with community-acquired pneumonia

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Abstract

Introduction: Community-acquired pneumonia (CAP) remains a major cause of morbidity and mortality in elderly patients. Early identification of high-risk individuals is crucial for improving outcomes. Biomarkers derived from routine laboratory tests, such as the lactate / albumin (L/A) ratio, may provide valuable prognostic information.

Methodology: This retrospective, two-center observational study included patients aged ≥ 65 years who were hospitalized with CAP between January 2021 and December 2024. Demographic characteristics, comorbidities, clinical severity scores, and laboratory parameters obtained at hospital admission were analyzed. Laboratory-derived ratios, including L/A, C-reactive protein/albumin (CRP/A), procalcitonin/albumin (PCT/A), and lactate dehydrogenase/albumin (LDH/A), were calculated. Receiver operating characteristic (ROC) analysis and logistic regression were performed to assess predictors of in-hospital mortality.

Results: A total of 150 patients were included, of whom 24% died during hospitalization. Non-survivors had significantly higher comorbidity burden, quick sepsis-related organ failure assessment (qSOFA) scores, lactate levels, and biomarker-based ratios. The L/A ratio was significantly associated with mortality ($p < 0.001$) and demonstrated moderate diagnostic performance (area under ROC, AUC = 0.263), with relatively favorable sensitivity and negative predictive value. Among the evaluated clinical scores, qSOFA showed the most balanced discriminatory performance. Multivariate analysis identified baseline oxygen saturation, Glasgow coma scale, albumin, and lactate levels as independent predictors of mortality.

Conclusions: The L/A ratio is a readily available biomarker associated with mortality in elderly patients with CAP. Although not a standalone predictor, it may serve as a complementary prognostic tool alongside established clinical severity scores, particularly during early patient assessment.

Key words: age; mortality; lactate; pneumonia.

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Introduction

Community-acquired pneumonia (CAP) is one of the leading causes of mortality worldwide and is one of the most common causes of hospitalization in developed countries, especially among people who are over 65 years of age [1,2]. Worldwide aging of the population is predicted and it is estimated that the number of people over the age of 60 years will reach 2 billion in 2050 [3]. With the predicted increase in the elderly population in many countries, effective management of CAP is becoming more and more important [4]. Ageing often leads to physiological changes in individuals, including decreased mucociliary clearance and cough reflex, weakened airway clearance, and increased swallowing difficulties with frequent impairment of oropharyngeal motor functions. These changes affect the incidence of CAP [5].

It is critical to determine the severity of the disease during the initial evaluation in patients with CAP. Mortality is known to range between 5.1% and 57.3%, depending on the severity of the disease. Factors such as early classification according to mortality risk, admission type, diagnostic tests used, and choice of antibiotic treatment may affect prognosis and mortality [6]. The mortality rate was found to be high in cases requiring intensive care hospitalization [7]. Therefore, there is a need for indices that can be used in clinical practice to predict the development of CAP, and biomarkers that can be used to predict prognosis in the elderly.

The serum lactate (L) level is used to determine the

level of tissue hypoxia and has been shown to be associated with mortality in sepsis [8]. Albumin (A) is a negative acute phase reactant and is a prognostic indicator of the severity of inflammation [9]. Procalcitonin (PCT) is an important risk factor indicator that is significantly increased in bacterial infections [10]. Therefore, it has been observed in the literature that albumin and albumin-based ratios are used as a prognostic indicator in the evaluation of patients with infection. Lactate/albumin (L/A) and C-reactive protein/albumin (CRP/A) ratios have been used to predict the severity and prognosis of patients with pneumonia and sepsis [11].

The aim of this study was to investigate the L/A ratio and other biomarkers associated with mortality and prognosis in CAP patients who are over 65 years of age, and to determine specific L/A values that may be useful in predicting mortality as a prognosis factor in the future.

Methodology

Study design, setting, and participants

In this retrospective, two-centre observational study, a total of 347 patients over 65 years of age with a diagnosis of pneumonia who visited the emergency department and outpatient clinics of the Training and Research Hospital, and who were hospitalized in the chest diseases service and intensive care unit between January 2021 and December 2024 were included. Patients with other pulmonary infiltrative diseases such as hospital-acquired pneumonia, radiation pneumonia, organised pneumonia, drug-induced pneumonia, active lung cancer, tuberculosis, fungal infection and empyema; and patients with missing albumin values in the first 24 hours were excluded. The study included patients who presented with a history of fever at the time of referral to the clinic or at hospital admission, had at least one respiratory symptom (cough, sputum production, dyspnoea, wheezing, or rales), and had new pulmonary infiltrates detected on chest radiography or computed tomography. Community-acquired pneumonia was defined as pneumonia diagnosed at hospital admission in patients without recent hospitalization or residence in a long-term care facility. Patients with hospital-acquired, ventilator-associated, or healthcare-associated pneumonia were excluded based on admission history and medical records. The study analyzed 150 patients meeting the inclusion criteria.

This study complied with the standards of medical ethics as endorsed by decision 06-2024/16, dated 30 May 2024, of the Ethics Committee of Karamanoğlu Mehmetbey University. Informed consent was not obtained due to the retrospective nature of the study and the use of anonymized patient data. Administrative permission to access patient medical records was obtained from the hospital administration. All clinical and laboratory data were de-identified prior to analysis and stored in secure systems accessible only to the investigators. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Variables

All data were collected from the hospital information management system electronic medical records. Demographic data; comorbid diseases; length of hospital stay; prognostic scores including saturation value, Glasgow coma scale, Charlson comorbidity index (CCI), confusion, urea, respiratory rate, blood pressure, and age ≥65 years (CURB-65), and quick sepsis-related organ failure assessment (qSOFA) scores were recorded. Clinical, laboratory, and radiological imaging data were analyzed. Prognostic clinical scores (CURB-65, qSOFA, Glasgow coma scale, and Charlson comorbidity index) and laboratory parameters including lactate, albumin, C-reactive protein (CRP), PCT, lactate dehydrogenase (LDH), D-dimer, and creatinine were obtained from routinely collected electronic medical records at hospital admission. In addition, laboratory-derived ratios reflecting inflammatory and metabolic burden—namely L/A, CRP/A, procalcitonin/albumin (PCT/A), and LDH/albumin (LDH/A)—were calculated a priori based on their established validation and documented prognostic relevance in CAP and sepsis.

Definitions

The diagnosis of CAP was made in the presence of radiological appearance of new and/or progressive pulmonary infiltrates and at least two of the following conditions: cough, sputum or change in sputum characteristics, dyspnoea, tachypnoea, abnormal breath sounds, pleuretic chest pain, auscultatory findings on chest examination consistent with pulmonary infiltrates, documentation of axillary body temperature ≥ 37.5 °C in the last 24 hours, chills and/or shivering, general malaise, and white blood cell (WBC) count ≥ 10,000/μL or < 3,000/μL [12].

Statistical analysis

Descriptive statistics of continuous variables were expressed as mean ± SD, and descriptive statistics of categorical values were presented as frequency and percentage. Independent sample t test and Mann

Whitney U test were used to compare quantitative data. Chi square and likelihood tests were used for the relationship analysis of categorical variables. Binary logistic regression analysis was performed for mortality. Pearson correlation analysis was performed to analyze the relationship of continuous variables. The receiver operating characteristic (ROC) curve was used for determining the cutoff points for the L/A, CRP/A, PCT/A, and LDH/A ratios. ROC analysis was performed to identify the best cutoff value for mortality prediction. The univariate/multivariate logistic regression analysis was used for evaluating variables which could have impact on mortality. Statistical analysis was performed using IBM SPSS 27.0 version (IBM Corp, Armonk, NY, USA). A significance level of $p < 0.05$ was adopted.

Results

A total of 347 patients diagnosed with CAP were analyzed, and 150 patients who were over 65 years of age and met the inclusion criteria were included in the study. Among them, 60% (n = 90) were male and 40% (n = 60) were female. The distribution of the places of admission was as follows: 76.67% (n = 115) emergency department admission and 23.23% (n = 35) outpatient clinic admission. Among the patients who were admitted, 1.33% (n = 2) declined hospitalization, 5.33% (n = 8) were discharged as voluntary, 69.33% (n = 104) were discharged with cure, and 24% (n = 36) of the hospitalized patients died. Microorganisms were isolated from 8.66% (n = 13) of the blood cultures and 31.33% (n = 47) of the sputum cultures. The mean values of the demographic and clinical variables of the patients were as follows: age 75.85 ± 8.12 years, hospitalization days 15.09 ± 12.66 days, number of comorbidities 2.31 ± 1.21, saturation value 83.68%± 10.12, Glasgow coma score 13.67 ± 1.92, CCI 2.83 ± 1.41, qSOFA score 1.46 ± 0.72, CURB-65 2.91 ± 0. 94, WBC 12.75 ± 5.65, neutrophils 11.88 ± 11.36, PLT 266.10 ± 109.23, glucose 152.53 ± 68.43, albumin 34.3 ± 5.05g/L, LDH 352.1 ± 262.25 U/L, CRP 101.25 ± 77.64 mg/L, lactate 2.02 ± 1.24 mmol/L, PCT 2.49 ± 9.81 ug/L, PCT/A 0.08 ± 032, CRP/A 3.15 ± 2.63, L/A 0.06 ± 0.04, LDH/A 10.98 ± 12.73, D-dimer 3.43 ± 7.37 mg/L, and creatine 1.06 ± 0.55 mg/dL The baseline characteristics of the admission survival and non-survival groups are listed in Table 1.

The relationship between mortality and clinical variables was analyzed. Days of hospitalization ($p < 0.001$), number of comorbid diseases ($p < 0.001$), baseline saturation value ($p < 0.001$), Glasgow coma score ($p < 0.001$), CCI ($p < 0.001$), qSOFA score ($p < 0.001$), albumin ($p < 0.001$), LDH ($p = 0. 041$), lactate ($p = 0.002$), PCT ($p < 0.001$), PCT/A ($p < 0.001$), CRP/A ($p = 0.004$), L/A ($p < 0.001$), LDH/A ($p = 0.001$), D-dimer ($p < 0.001$), and creatinine ($p = 0.009$) were found to be statistically significantly different between the survival and non-survival groups. No statistically significant difference was observed between the groups in terms of patient age, CURB-65,

Table 1. Clinical characteristics of the study population.

	Total	Survival	Non-survival	*p* value
	n = 150	n = 114	n = 36	
Age	75.85 ± 8.12	75.25 ± 7.42	77.75 ± 9.90	0.108*
Patient hospitalization day	15.09 ± 12.66	12.39 ± 8.82	23.50 ± 18.18	< 0.001**
Number of additional diseases	2.31 ± 1.21	2.04 ± 0.99	3.19 ± 1.43	< 0.001*
Saturation	83.68 ± 10.12	85.45 ± 9.72	78.08 ± 9.40	< 0.001**
Glasgow coma scale	13.67 ± 1.92	14.25 ± 1.03	11.86 ± 2.79	< 0.001**
CCI	2.83 ± 1.41	2.68 ± 1.27	3.28 ± 1.73	< 0.001*
qSOFA score	1.46 ± 0.72	1.29 ± 0.62	2.00 ± 0.76	< 0.001*
CURB-65	2.91 ± 0.94	2.64 ± 0.74	3.78 ± 0.99	0.423*
WBC	12.75 ± 5.65	12.54 ± 5.36	13.41 ± 6.51	0.893*
Neutrophil	11.88 ± 11.36	11.95 ± 12.57	11.66 ± 6.27	0.652**
Albumin	34.30 ± 5.05	35.42 ± 4.39	30.74 ± 5.41	< 0.001*
LDH	352.10 ± 262.25	320.32 ± 150.13	445.56 ± 444.41	0.041**
CRP	101.25 ± 77.64	94.71 ± 77.34	121.94 ± 75.96	0.066*
Lactate	2.02 ± 1.24	1.84 ± 1.13	2.56 ± 1.41	0.002*
PCT	2.49 ± 9.81	1.76 ± 7.80	4.57 ± 14.01	< 0.001**
PCT/A	0.08 ± 0.32	0.05 ± 0.24	0.16 ± 0.48	< 0.001**
CRP/A	3.15 ± 2.63	2.81 ± 2.42	4.24 ± 2.99	0.004*
L/A	0.06 ± 0.04	0.05 ± 0.03	0.09 ± 0.06	< 0.001**
LDH/A	10.98 ± 12.73	9.19 ± 4.54	16.26 ± 23.51	0.001**
D-dimer	3.43 ± 7.37	2.68 ± 6.83	6.02 ± 8.62	< 0.001**
Creatinine	1.06 ± 0.55	0.99 ± 0.49	1.28 ± 0.66	0.009**

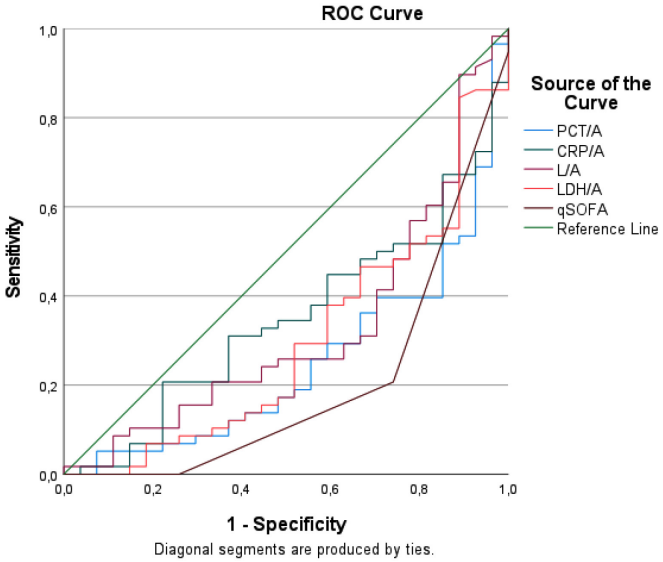
*Independent sample *t*-test; **; Mann Whitney U-test; ***: Chi square; ****: Likelihood ratio. CCI: Charlson comorbidity ındex; qSOFA: quick sequential organ failure assessment; CURB-65: confusion: urea: respiratory rate: blood pressure: age ≥ 65 years score; WBC: white blood cell count; LDH: lactate dehydrogenase; CRP: C-reactive protein; PCT: procalcitonin; CRP/A: C-reactive protein to albumin ratio; PCT/A: procalcitonin to albumin ratio; L/A: lactate to albumin ratio; LDH/A: lactate dehydrogenase to albumin ratio.

WBC, neutrophil count, and CRP values (Table 1).

Number of comorbid diseases, baseline saturation value, Glasgow coma score, CCI, qSOFA score, albumin, lactate, CRP/A, and creatinine were identified as significant independent risk factors based on logistic regression analysis of the mortality data. In addition, baseline saturation value (OR = 0.949, 95% CI 0.903–0.997, p = 0.037), Glasgow coma score (OR = 0.518, 95% CI 0.374–0.717, $p < 0.001$), albumin (OR = 0.810, 95% CI 0.719–0.914, p = 0.001), and lactate (OR = 1.772, 95% CI 1.127–2.787, p = 0.013) were identified as independent risk factors of mortality based on multivariate and last model regression analysis (Table 2).

The ROC curves were plotted to predict mortality using the PCT/A ratio, CRP/A ratio, L/A ratio, and LDH/A ratio. The area under the curve (AUC) for ROC was 0.356 for PCT/A (95% CI 0.266–0.446, p = 0.009), 0.345 for CRP/A (95% CI 0.249–0.441, p = 0.005), 0.263 for L/A (95% CI 0.172–0.355, $p < 0.001$), and 0.374 for LDH/A (95% CI 0.277–0.471, p = 0.023) (Figure 1). When evaluating the performance of PCT/A, CRP/A, L/A, LDH/A, and qSOFA scores in predicting mortality; qSOFA and L/A demonstrated the most balanced diagnostic performance. For example, the cut-off for qSOFA, was 1.5, sensitivity was 72.2%, specificity was 71.1%, accuracy was 71.3%, LR+ was 2.49, and LR− was 0.39. The cut-off for L/A, was 0.066, sensitivity was 70.9%, specificity was 66.7%, accuracy was 67.8%, LR+ was 2.13, and LR− was 0.44; providing moderate prediction. The PCT/A, CRP/A, and LDH/A ratios, however, showed more limited performance, and their relatively high negative predictive values suggest that low values are more reliable in predicting survival. These findings indicate that evaluating biomarkers and clinical scores together, rather than a single biomarker, yields more meaningful results in mortality prediction (Table 3).

Figure 1. Analysis of receiver operating characteristic curve (ROC) to predict mortality of community acquired pneumonia (CAP) patients.



The area under the curve (AUC) was 0.356 for PCT/A (p = 0.009), 0.345 for CRP/A (p = 0.005), 0.263 for L/A ($p < 0.001$), and 0.374 for LDH/A (p = 0.023), and 0.247 for qSOFA ($p < 0,001$). PCT/A: procalcitonin/albumin; CRP/A: C-reactive protein/albumin; L/A: lactate/albumin; LDH/A: lactate dehydrogenase/albumin; qSOFA: quick sepsis-related organ failure assessment.

Table 2. Univariate, multivariate, and last model logistic regression analysis of various parameters associated with fatal outcomes for mortality.

	Univariate analysis		Multivariate analysis		Last model	
	OR (95% CI)	*p* value	OR (95% CI)	*p* value	OR (95% CI)	*p* value
Patient hospitalization days	1.000 (0.999–1.001)	0.594				
Number of additional diseases	2.367 (1.626–3.446)	< 0.001	1.515 (0.916–2.506)	0.106		
Saturation	0.915 (0.869–0.964)	0.001	0.952 (0.908–0.998)	0.039	0.949 (0.903–0.997)	0.037
Glasgow coma scale	0.478 (0.362–0.631)	< 0.001	0.597 (0.397–0.898)	0.013	0.518 (0.374–0.717)	< 0.001
CCI	1.334 (1.025–1.736)	0.032	0.848 (0.548–1.313)	0.460		
qSOFA score	4.124 (2.237–7.601)	< 0.001	1.603 (0.614–4.185)	0.335		
Albumin	0.812 (0.741–0.891)	< 0.001	0.801 (0.691–0.929)	0.003	0.810 (0.719–0.914)	0.001
LDH	1.000 (1.000–1.000)	0.359				
Lactate	1.532 (1.136–2.066)	0.005	1.722 (1.068–2.776)	0.026	1.772 (1.127–2.787)	0.013
PCT	1.000 (1.000–1.000)	0.159				
PCT/A	1.000 (1.000–1.000)	0.158				
CRP/A	1.216 (1.058–1.397)	0.006	0.901 (0.698–1.163)	0.424		
L/A	1.000 (0.999–1.001)	0.995				
LDH/A	1.000 (1.000–1.000)	0.272				
D-dİmer	1.000 (1.000–1.000)	0.390				
Creatine	2.380 (1.202–4.712)	0.013	1.340 (0.586–3.065)	0.489		

CCI: Charlson comorbidity ındex; qSOFA: quick sequential organ failure assessment; LDH: lactate dehydrogenase; PCT: procalcitonin; PCT/A: procalcitonin to albumin ratio; CRP/A: C-reactive protein to albumin ratio; L/A: lactate to albumin ratio; LDH/A: lactate dehydrogenase to albumin ratio.

Table 3. Receiver operating characteristic (ROC) analysis of laboratory-derived ratios for predicting mortality in elderly patients with community-acquired pneumonia (CAP).

	AUC	95% CI	*p*	Cut-off	Sensitivity	Specificity	PPV	NPV	LR+	LR-	Accuracy
PCT/A	0.356	0.266–0.446	0.009	0.008	0.5862	0.6567	0.425	0.7857	1.7076	0.6301	0.6354
CRP/A	0.345	0.249–0.441	0.005	2.98	0.6452	0.5119	0.3279	0.7963	1.3218	0.6932	0.5478
L/A	0.263	0.172–0.355	< 0.001	0.066	0.7097	0.6667	0.44	0.8615	2.129	0.4355	0.6783
LDH/A	0.374	0.277–0.471	0.023	9.158	0.5714	0.6667	0.4103	0.7931	1.7143	0.6429	0.6392
qSOFA	0.247	0.151–0.344	< 0.001	1.5	0.7222	0.7105	0.4407	0.8901	2.4949	0.3909	0.7133

PCT/A: procalcitonin to albumin ratio; CRP/A: C-reactive protein to albumin ratio; L/A: lactate to albumin ratio; LDH/A: lactate dehydrogenase to albumin ratio; qSOFA: quick sequential organ failure assessment; AUC: area under ROC; PPV: positive predictive value; NPV: negative predictive value; LR: likelihood ratio.

Correlation analysis of the clinical variables of the patients was performed. Accordingly, there was a statistically significant positive correlation between the number of comorbid diseases and CCI (r = 0.432; $p < 0.001$) and CURB-65 (r = 0.472; $p < 0.001$) values. There was a statistically significant negative correlation between Glasgow coma score and qSOFA score (r = – 0.601; $p < 0.001$) and CURB-65 value (r = – 0.604; $p < 0.001$). There was a statistically significant positive correlation between qSOFA score and CURB-65 value (r = 0.624; $p < 0.001$).

There was a statistically significant positive correlation between LDH value, and L/A ratio (r = 0.523; $p < 0.001$) and LDH/A ratio (r = 0.961; $p < 0.001$). There was a statistically significant positive correlation between CRP value and CRP/A ratio (r = 0.965; $p < 0.001$). There was also a statistically significant positive correlation between L/A ratio and LDH/A ratio (r = 0.596; $p < 0.001$). This study showed that there were specific correlations between clinical parameters in elderly CAP patients. The results of the correlation analysis of the continuous variables of the patients are summarized in Table 4.

Discussion

CAP is more common and has more serious consequences in elderly people than in the younger population. With the increasing geriatric ageing of the population, its medical and economic impact on the economy increases and poses a major threat. In addition, it has been reported that the mortality rate in elderly patients increases up to 30% due to the presence of comorbid diseases, nutritional status, and cognitive impairment [13]. A study in Japan reported that among the new cases of CAP, approximately 70% were over 65 years of age and 70% of these elderly patients were hospitalized. Age, male gender, and comorbidities were risk factors for CAP [14]. In this study, no significant relationship was found between age and mortality, as has also been reported in previous studies [15].

In the present study, there was a statistically significant correlation between an increase in the number of comorbid diseases and mortality ($p < 0.001$). Previous studies have observed that comorbid diseases

Table 4. Correlation analysis results.

		1	2	3	4	5	6	7	8	9	10	11
Age	r	1										
	p											
Number of comorbidities	r	0.038	1									
	p	0.643										
Glasgow coma score	r	- 0.183	-0.329	1								
	p	0.025	0.000									
CCI	r	- 0.038	0.432	- 0.217	1							
	p	0.645	0.000	0.008								
qSOFA score	r	0.176	0.265	- 0.601	0.224	1						
	p	0.031	0.001	0.000	0.006							
CURB-65	r	0.207	0.472	- 0.604	0.135	0.624	1					
	p	0.011	0.000	0.000	0.099	0.000						
LDH	r	0.052	0.093	- 0.190	0.030	0.117	0.166	1				
	p	0.549	0.283	0.028	0.727	0.177	0.056					
CRP	r	0.083	0.183	- 0.072	0.169	0.176	0.227	0.092	1			
	p	0.312	0.025	0.383	0.039	0.031	0.005	0.289				
CRP/A	r	0.099	0.227	- 0.141	0.226	0.228	0.264	0.188	0.965	1		
	p	0.226	0.005	0.085	0.005	0.005	0.001	0.030	0.000			
L/A	r	- 0.024	0.210	- 0.221	0.066	0.152	0.222	0.523	0.108	0.202	1	
	p	0.768	0.010	0.007	0.420	0.063	0.006	0.000	0.190	0.013		
LDH/A	r	0.066	0.141	- 0.189	0.040	0.136	0.182	0.961	0.128	0.260	0.596	1
	p	0.446	0.105	0.029	0.644	0.116	0.036	0.000	0.142	0.002	0.000	

CCI: Charlson comorbidity ındex; qSOFA: quick sequential organ failure assessment; CURB-65: confusion: urea: respiratory rate: blood pressure: age ≥ 65 years score; LDH: lactate dehydrogenase; CRP: C-reactive protein; CRP/A: C-reactive protein to albumin ratio; L/A: lactate to albumin ratio; LDH/A: lactate dehydrogenase to albumin ratio.

and other characteristics of the patients affect the severity and prognosis of CAP [14–16]. Therefore, considerable emphasis should be placed on the fact that mortality may increase in patients with three and/or more comorbid diseases, as found in this study. In this study, Glasgow coma scale, qSOFA, and CCI were found to be statistically significant ($p < 0.001$), similar to observations in previous studies [17–19]. No statistically significant relationship was found between CURB-65 and mortality ($p = 0.423$). However, a statistically significant correlation was found between D-dimer level and mortality in patients over 65 years of age with CAP ($p < 0.001$). Although some previous studies have reported that D-dimer levels have no significant correlations with in-hospital mortality and length of intensive care unit stay [20], other studies have reported correlation between D-dimer levels and mortality [21].

It has been shown previously that the initial serum lactate level is an independent risk factor for mortality in hospitalized patients with CAP [22]. Serum albumin level is used as a prognostic factor because it is potentially decreased in patients with infectious diseases. Albumin and CRP have been found to be associated with mortality in patients hospitalized with CAP [23]. The ratio of these two values was found to be associated with mortality, and the L/A ratio, was found to be associated with multiple organ failure and mortality in critically septic patients; therefore, the use of these parameters as prognostic markers was recommended [24].

In this study, it was found that the L/A ratio was associated with intensive care unit and in-hospital mortality, and it demonstrated comparable performance to lactate in predicting mortality in patients with severe infections. However, some studies have reported that L/A ratio is better than lactate and albumin individually in estimating hospital mortality in adult sepsis patients [25,26]. In the present study, L/A ratio was found to be highly statistically significant in determining prognosis ($p < 0.001$), as has also been reported previously [27]. L/A was also more significant than lactate level alone ($p = 0.002$). The LDH/A ratio; previously reported to be an important prognostic factor in studies conducted in patients with pneumonia, lower respiratory tract infection, and sepsis; was found to be significant in a similar manner [11,28,29]. In addition, PCT/A ($p < 0.001$) and CRP/A ($p = 0.004$) ratios that are accepted as important prognostic factors in accordance with studies conducted in sepsis, were also found to be significant [30,31]. The L/A ratio was further evaluated in the context of established severity scores such as pneumonia severity index (PSI), CURB-65, and qSOFA to clarify its potential incremental clinical value. While these scoring systems are well validated for risk stratification in CAP, they require multiple clinical and laboratory variables and may be time-consuming to calculate in acute care settings. In contrast, the L/A ratio can be rapidly derived from routinely obtained laboratory parameters and demonstrated relatively favorable sensitivity for mortality prediction in the cohort. This finding suggests that L/A may be useful for early identification of patients at increased risk, particularly by reducing false-negative assessments. When compared with qSOFA, which is known to prioritize specificity over sensitivity in some clinical contexts, the higher sensitivity observed for L/A supports its potential role as an early warning biomarker. Although PSI and CURB-65 strains have independently proven prognostic, their complexity can lead to delays in rapid clinical application. Therefore, rather than replacing established severity scores, the L/A ratio may serve as a complementary prognostic tool during initial evaluation and may enhance clinical decision-making when used alongside traditional scoring systems.

When the AUC values of PCT/A, CRP/A, LDH/A ratios, that are the frequently used prognostic factors, were compared, a lower AUC value was found for L/A (AUC values: 0.356; 0.345; 0.374 > 0.263, respectively). It should also be noted that the numerical value and direction of the AUC depend on how the outcome variable is coded; however, this does not affect the statistical significance of the test performance or its clinical interpretation [32].

Although the AUC values of the L/A ratio were relatively low, the ratio showed favorable sensitivity and negative predictive value, suggesting a potential role in identifying lower-risk patients rather than serving as a definitive prognostic marker. Such performance characteristics may provide clinically meaningful information beyond AUC alone in elderly populations with substantial comorbidity burden and multifactorial mortality. Therefore, the L/A ratio should be interpreted as a complementary biomarker to established clinical severity scores.

Limitations

This study has several limitations that should be acknowledged. First, the retrospective and two-center design represents an important limitation. In addition, standardized frailty indices, body mass index, and functional status assessments could not be included in the analysis due to the lack of consistent and complete

data. Consequently, the interaction between frailty, nutritional status, and biomarker-based prognostic models could not be comprehensively evaluated. Therefore, future prospective studies incorporating detailed and standardized clinical assessments are warranted to better elucidate these relationships.

Another limitation of this study is that biomarker measurements were based solely on single baseline values obtained at the time of hospital admission. Serial measurements of lactate, albumin, and the derived ratios were not routinely available in this retrospective dataset; therefore, dynamic temporal changes in these biomarkers and their potential prognostic significance could not be assessed.

Conclusions

The L/A ratio, as an easy-to-measure biomarker, may serve as a useful prognostic biomarker for mortality in CAP patients who are over 65 years of age and admitted to the intensive care unit. Its widespread use as a prognostic marker may guide us to future studies.

Authors' contributions

Yİ: conceptualization, data curation, formal analysis, investigation, methodology, project administration, resources, writing—original draft, writing—review and editing; SA: conceptualization, data curation, formal analysis, supervision, validation, writing—original draft, writing—review and editing; AŞ: conceptualization, data curation, formal analysis; AÇ: conceptualization, data curation.

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Conflict of interest

No conflict of interest is declared.

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