Am J Transl Res 2026;18(7):6421-6430
www.ajtr.org /ISSN:1943-8141/AJTR0173445

Original Article

Expression and clinical significance of serum C-reactive protein and blood lactate levels in elderly patients with chronic obstructive pulmonary disease complicated by acute lower respiratory tract infection

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Received April 20, 2026; Accepted June 17, 2026; Epub July 15, 2026; Published July 30, 2026

Abstract: Objective: To evaluate serum C-reactive protein (CRP) and blood lactate levels in elderly patients with Chronic Obstructive Pulmonary Disease (COPD) complicated by acute lower respiratory tract infection (ALRTI). Methods: A total of 265 elderly COPD patients (age ≥ 65 years) were retrospectively analyzed. According to the presence of ALRTI, patients were divided into an ALRTI group (n = 160) and a non-ALRTI group (n = 105). Serum CRP and blood lactate levels were measured within 24 hours of admission. Results: Compared with the non-ALRTI group, the serum CRP and lactate levels were significantly higher in the ALRTI group (both $P < 0.01$). Elevated CRP (OR = 3.22) and blood lactate (OR = 2.78) were independent risk factors for ALRTI. Both markers were positively correlated with Confusion, Urea, Respiratory rate, Blood pressure, Age ≥ 65 years (CURB-65) score ($r = 0.452$ and $r = 0.387$, both $P < 0.001$). The area under the receiver operating characteristic (ROC) curve (AUC) for the combination of CRP and lactate in predicting intensive care unit (ICU) admission was 0.835 [95% confidence interval (CI): 0.782-0.888], which was superior to either marker alone. Conclusion: Serum CRP and lactate levels are significantly elevated in elderly COPD patients complicated with ALRTI and are associated with disease severity. Their combined detection may improve the identification of high-risk patients and prediction of ICU admission.

Keywords: Inflammatory response, acute lower respiratory tract infection, influencing factors, lactic acid level, regression analysis

Introduction

Chronic obstructive pulmonary disease (COPD) is a chronic respiratory disease characterized by persistent airflow limitation, which is closely associated with enhanced chronic inflammatory response of the airways and lung parenchyma to noxious particles or gases. It is characterized by high prevalence, high rates of missed diagnosis, and high mortality. The elderly population represents a high-risk group for COPD [1-3].

With the acceleration of population aging and the age-related decline in the physiological function of the respiratory system, elderly COPD patients exhibit notably decreased pulmonary ventilation and reduced gas exchange capacity, as well as weakened airway defense ability, increasing susceptibility to acute lower respiratory tract infection (ALRTI) [4, 5]. As the primary cause of acute exacerbation in elderly patients with COPD, ALRTI can lead to further deterioration of respiratory function and even induce serious complications such as respiratory failure and multiple organ dysfunction by aggravating airway inflammation, destroying lung parenchyma, and causing gas exchange disorder [6].

Currently, the diagnosis of COPD combined with ALRTI in elderly patients mainly depends

https://doi.org/10.62347/KJW05930

on clinical symptoms, imaging examination, and etiological detection [7]. However, clinical symptoms of elderly patients are often nonspecific, and some patients may present atypical symptoms such as fatigue and loss of appetite, which are easily overlooked. Imaging findings may lag behind clinical progression, limiting early detection of mild infection. In addition, pathogenic detection is time-consuming and doesn't meet the requirement for rapid clin-i cal diagnosis and disease assessment [8]. Therefore, the identification of simple, rapid, and sensitive biomarkers has become an urgent clinical need.

Serum C-reactive protein (CRP) is an acute-phase reactant synthesized by the liver in response to infection or inflammatory stimuli. Changes in CRP levels are closely associated with the severity of inflammatory response, showing diagnostic value for respiratory tract infection. Blood lactate, as an important indicator of tissue hypoperfusion and metabolic disorders, can indirectly reflect the severity of infection-related hypoxia and disease progression [8]. However, current evidence on the combined diagnostic and prognostic value of these two markers in elderly patients with COPD and ALRTI remains limited [9]. Based on this, the present study aimed to investigate the expression patterns of serum CRP and blood lactate levels in elderly COPD patients complicated with ALRTI, and to evaluate their predictive value for infection severity, treatment response, and prognosis, thereby providing a reliable reference for early clinical diagnosis, disease assessment, and treatment decision-making.

Data and methods

General information

The clinical data of 265 elderly patients with acute exacerbation of chronic obstructive pulmonary disease (AECOPD) admitted to the First Affiliated Hospital of Yangtze University from January 2023 to December 2023 were retrospectively analyzed. According to the presence of acute lower respiratory tract infection (ALRTI) confirmed by etiology or imaging, patients were divided into an ALRTI group (n = 160) and a non-ALRTI group (n = 105). This study was approved by the Ethics Committee of the First Affiliated Hospital of Yangtze University (Approval No. KYLL: 20230087).

Inclusion criteria

(1) Age ≥ 65 years; (2) Diagnosis of COPD according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria, and in the acute exacerbation stage [10]; (3) Diagnosis of ALRTI based on at least one of the following criteria in addition to clinical manifestations: Positive pathogen detection from sputum culture, blood culture, or other appropriate respiratory specimens; New or progressive infiltrates on chest X-ray or computed tomography (CT); Laboratory evidence of infection, including elevated white blood cell (WBC) count, increased neutrophil percentage, or elevated procalcitonin (PCT); (4) Complete clinical data available after admission; (5) First hospitalization for pulmonary infection in our hospital; (6) No medical disputes during hospitalization.

Exclusion criteria

(1) Coexisting respiratory diseases such as bronchial asthma, bronchiectasis, or interstitial lung disease; (2) Malignant tumors or severe dysfunction of the heart, liver, or kidneys; (3) Use of glucocorticoids or immunosuppressive agents within 2 weeks before admission; (4) Patients with a history of autoimmune diseases; (5) Incomplete clinical data.

Data collection

The general information of patients was obtained from the electronic medical record system, including baseline data, laboratory test results, and clinical outcomes.

Baseline data: Demographic and clinical variables were recorded, including age, sex, COPD duration, smoking history, comorbidities (hypertension, diabetes mellitus, coronary heart disease), body temperature, respiratory rate, heart rate, and level of consciousness. The Confusion, Urea, Respiratory rate, Blood pressure, and age ≥ 65 years (CURB-65) score was calculated to assess disease severity in patients with pneumonia.

Laboratory indices: Venous blood samples were collected within 24 hours of admission. Serum CRP levels were measured using immunoturbidimetry (Beckman Coulter AU5800). Blood lactate levels were detected using a

blood gas analyzer (GEM Premier 3500). All procedures were performed in strict accordance with the standard operating procedures provided by the reagent manufacturer.

Diagnostic criteria for ALRTI: ALRTI was diagnosed if at least one of the following criteria was met: (1) positive sputum or blood culture; (2) chest X-ray or CT showing new pulmonary infiltrates, consolidation, or pleural effusion consistent with acute infection; (3) clinical manifestations including fever, cough, sputum, pulmonary rales consistent with ALRTI.

Clinical outcome: Length of hospital stay, intensive care unit (ICU) admission, and 28-day mortality were recorded.

Outcome measures

Primary outcome measures: Serum CRP and blood lactate levels were compared between the ALRTI group and the non-ALRTI group.

Secondary outcome measures: The correlation between serum CRP, blood lactate levels, and disease severity (CURB-65 score) was analyzed.

The predictive performance of serum CRP, blood lactate, and their combination for ICU admission was evaluated.

Statistical analysis

SPSS 26.0 (IBM) was used for all statistical analyses. The normality of continuous variables was assessed using the Shapiro-Wilk test. Normally distributed continuous variables were expressed as mean ± standard deviation (SD) and compared using the independent samples t-test. Non-normally distributed variables were expressed as median (IQR) and compared using the Mann-Whitney U test. Categorical variables were expressed as n (%) and compared using the χ^2 test or Fisher's exact test, as appropriate.

Univariate logistic regression analysis was first performed to identify potential risk factors for ALRTI in elderly COPD patients, including age, sex, COPD duration, smoking history, comorbidities, CRP, and lactate. Variables with $P < 0.10$ were entered into a multivariate binary logistic regression model using backward stepwise selection (entry $\alpha = 0.05$, removal $\alpha = 0.10$). Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. Spearman's rank correlation analysis was used to evaluate the correlation between CRP, lactate, and CURB-65 score, with correlation coefficients (r) and 95% CIs reported. Receiver operating characteristic (ROC) curve analysis was performed to evaluate the predictive performance of CRP, lactate, and their combination for both ALRTI and ICU admission. The area under the curve (AUC), 95% CI, optimal cutoff values (Youden's index), sensitivity, and specificity were calculated. Model calibration was assessed using the Hosmer-Lemeshow goodness-of-fit test, and model explanatory power was assessed using Nagelkerke R^2. A two-tailed $P < 0.05$ was considered statistically significant.

Results

Comparison of baseline characteristics between the ALRTI and non-ALRTI groups

A total of 265 elderly patients with AECOPD were included in this study, including 160 patients in the ALRTI group and 105 patients in the non-ALRTI group. As shown in **Table 1**, there were no significant differences between the two groups in terms of age, sex, BMI, smoking history, COPD course, pulmonary function (FEV1%pred), or comorbidities (e.g., hypertension, diabetes, coronary heart disease) (all $P > 0.05$), indicating comparability between the groups.

Comparison of liver and kidney function parameters between the two groups

As shown in **Table 2**, there was no significant difference in liver function indexes (ALT, AST, ALP, GGT, TBIL, ALB) and renal function indexes (Cr, BUN, UA, eGFR) between the two groups (all $P > 0.05$). See **Table 2**.

Comparison of CRP and lactate levels between the two groups

As shown in **Table 3**, serum CRP levels were significantly higher in the ALRTI group [median (IQR): 45.6 (32.1-58.3) mg/L] than in the non-ALRTI group [18.3 (12.5-24.6) mg/L] ($Z = 6.845$, $P < 0.001$). Similarly, the lactate levels were significantly higher in the ALRTI group [2.35 (1.85-3.02) mmol/L] than in the non-ALR-

Table 1. Comparison of baseline characteristics between the ALRTI and non-ALRTI groups

Variable	Non-ALRTI group (n = 105)	ALRTI group (n = 160)	X^2/t/Z value	*P* value
Age (years, $\bar{x} \pm s$)	72.5 ± 6.0	72.8 ± 6.2	0.386	0.700
Male [n (%)]	61 (58.1)	97 (60.6)	0.170	0.680
Consciousness status (alert) [n (%)]	100 (95.2)	150 (93.8)	0.242	0.623
Respiratory rate (breaths/min, $\bar{x} \pm s$)	22.8 ± 3.0	23.0 ± 3.1	0.520	0.603
Body temperature (°C, $\bar{x} \pm s$)	38.3 ± 0.7	38.4 ± 0.7	1.145	0.253
CURB-65 score ($\bar{x} \pm s$)	1.9 ± 1.0	2.0 ± 1.0	0.795	0.427
CURB-65 score category [n (%)]			1.824	0.402
Low risk (0-1)	48 (45.7)	65 (40.6)		
Moderate risk (2)	40 (38.1)	65 (40.6)		
High risk (3-4)	17 (16.2)	30 (18.8)		
COPD duration (years, $\bar{x} \pm s$)	8.8 ± 4.5	9.0 ± 4.6	0.351	0.726
Smoking history [n (%)]	56 (53.3)	88 (55.0)	0.074	0.786
Underlying diseases [n (%)]				
Hypertension	38 (36.2)	58 (36.3)	0.000	0.990
Diabetes	20 (19.0)	32 (20.0)	0.038	0.846
Coronary heart disease	15 (14.3)	24 (15.0)	0.026	0.872

Notes: ALRTI: acute lower respiratory tract infection; COPD: Chronic Obstructive Pulmonary Disease; CURB-65: Confusion, Urea, Respiratory rate, Blood pressure, Age ≥ 65 years.

Table 2. Comparison of liver and kidney function parameters between the two groups (Mean ± SD)

Indicators	ALRTI group (n = 160)	Non-ALRTI group (n = 105)	t value	*P* value
Liver function				
ALT (U/L)	28.5 ± 12.3	26.8 ± 11.5	1.142	0.254
AST (U/L)	30.2 ± 14.1	28.5 ± 13.2	1.012	0.312
ALP (U/L)	85.6 ± 22.4	82.3 ± 21.8	1.201	0.231
GGT (U/L)	32.4 ± 15.6	30.1 ± 14.8	1.214	0.226
TBIL (μmol/L)	12.5 ± 4.2	11.8 ± 3.9	1.402	0.162
ALB (g/L)	38.6 ± 4.5	39.2 ± 4.3	1.102	0.271
renal function				
Cr (μmol/L)	68.5 ± 15.6	65.2 ± 14.8	1.732	0.084
BUN (mmol/L)	6.2 ± 1.8	5.9 ± 1.6	1.408	0.160
UA (μmol/L)	342.5 ± 85.6	328.6 ± 79.5	1.358	0.176
eGFR (mL/min/1.73 m^2)	85.6 ± 18.5	88.2 ± 17.6	1.165	0.245

Note: ALRTI, acute lower respiratory tract infection; ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALP, alkaline phosphatase; GGT, gamma-glutamyl transferase; TBIL, total bilirubin; ALB, albumin; Cr, creatinine; BUN, blood urea nitrogen; UA, uric acid; eGFR, estimated glomerular filtration rate.

TI group [1.62 (1.28-1.95) mmol/L] (Z = 5.923, P < 0.001).

Comparison of clinical outcomes between the two groups

As shown in **Table 4**, the length of hospital stays in the ALRTI group [14.0 (10.0, 18.0) days] was significantly longer than that in the non-ALRTI group [9.0 (6.0, 13.0) days] (Z = 5.892, P < 0.001). Moreover, both the ICU admission rate (20.0% vs. 9.5%; χ^2 = 5.298, P = 0.021) and 28-day mortality rate (11.3% vs. 3.8%; χ^2 = 4.802, P = 0.028) were significantly higher in the ALRTI group than in the non-ALRTI group.

Table 3. Comparison of CRP and lactate levels between the two group

Variable	Non-ALRTI group (n = 105)	ALRTI group (n = 160)	Z value	*P* value
CRP (mg/L) [median (IQR)]	18.3 (12.5-24.6)	45.6 (32.1-58.3)	6.845	< 0.001
Lactate (mmol/L) [median (IQR)]	1.62 (1.28-1.95)	2.35 (1.85-3.02)	5.923	< 0.001

Notes: ALRTI: acute lower respiratory tract infection; IQR: Interquartile Range.

Table 4. Comparison of clinical outcomes between the two groups

Indicator	ALRTI group (n = 160)	Non-ALRTI group (n = 105)	Statistic value (Z/χ^2)	*P* value
Hospitalization time [days, Median (IQR)]	14.0 (10.0, 18.0)	9.0 (6.0, 13.0)	5.892	< 0.001
ICU transfer rate [n (%)]	32 (20.0)	10 (9.5)	5.298	0.021
28-day mortality [n (%)]	18 (11.3)	4 (3.8)	4.802	0.028

Notes: ICU: Intensive Care Unit; ALRTI: acute lower respiratory tract infection.

Table 5. Multivariate logistic regression analysis of independent risk factors for ALRTI in elderly patients with COPD

Variables	β value	SE	Wald χ^2	OR value	95% CI	*P* value
High level of CRP (≥ 10 mg/L)	1.169	0.284	16.94	3.22	1.85-5.61	< 0.01
Hyperlactatemia (lactate > 2.0 mmol/L)	1.022	0.275	13.82	2.78	1.62-4.77	< 0.01
Constant	-2.845	0.412	47.68	0.06	-	< 0.001

Notes: Both variables were converted into binary categorical variables based on these clinical cut-off values before being entered into the multivariate logistic regression model. ALRTI: acute lower respiratory tract infection; COPD: Chronic Obstructive Pulmonary Disease; CURB-65: Confusion, Urea, Respiratory rate, Blood pressure, Age ≥ 65 years; CRP: C-reactive protein.

Multivariate logistic regression analysis of risk factors for ALRTI in elderly patients with AECOPD

Taking the occurrence of ALRTI as the dependent variable (occurrence = 1, non-occurrence = 0), variables with P < 0.10 in the univariate analysis were included in the multivariate logistic regression model. The results showed that elevated CRP levels (OR = 3.22, 95% CI: 1.85-5.61, P < 0.01) and hyperlactacidemia (OR = 2.78, 95% CI: 1.62-4.77, P < 0.01) were independent risk factors for ALRTI in elderly COPD patients with (**Table 4**).

Correlation analysis between CRP, lactate level, and CURB-65 score in ALRTI group

In the ALRTI group, partial correlation analysis was conducted after adjusting for potential confounding factors (age, sex, COPD duration, smoking history, and comorbidities). As shown in **Table 5**, serum CRP levels were significantly correlated with CURB-65 score (partial r = 0.586, 95% CI: 0.468-0.685, P < 0.001), as were blood lactate level (partial r = 0.512, 95% CI: 0.384-0.622, P < 0.001). The combination of CRP and lactate showed the strongest partial correlation with CURB-65 score (partial r = 0.685, 95% CI: 0.584-0.766, P < 0.001).

Predictive performance of CRP and lactate levels for ICU admission

For ICU admission prediction, the AUC of CRP was 0.785 (95% CI: 0.724-0.846), with an optimal cut-off value of 32.5 mg/L, sensitivity of 75.0%, and specificity of 72.5%. The AUC of lactic acid was 0.742 (95% CI: 0.678-0.806), with an optimal cut-off value of 2.1 mmol/L, sensitivity of 68.8%, and specificity of 70.2%. Their combined prediction yielded an AUC of 0.835 (95% CI: 0.782-0.888), with a sensitivity of 81.3% and a specificity of 78.6% (**Tables 6**, **7**; **Figure 1**).

Internal validation of the predictive model

The Hosmer-Lemeshow goodness-of-fit test showed good calibration of the model (χ^2 = 8.973, P = 0.255), indicating no significant difference between predicted probabilities and observed outcomes. The Nagelkerke R^2 was

Table 6. Correlation analysis between CRP, lactate level, and CURB-65 score in ALRTI group

Variable	Unadjusted correlation coefficient (r)	Unadjusted 95% CI	*P* value	Partial correlation coefficient (r_partial)*	Adjusted 95% CI	*P* value
CRP vs. CURB-65 score	0.624	0.512-0.718	< 0.001	0.586	0.468-0.685	< 0.001
Lactate vs. CURB-65 score	0.558	0.436-0.662	< 0.001	0.512	0.384-0.622	< 0.001
CRP + lactate combined vs. CURB-65 score	0.712	0.618-0.788	< 0.001	0.685	0.584-0.766	< 0.001

Note: Partial correlation coefficients were adjusted for the following confounding variables: age, sex, body temperature, respiratory rate, COPD duration, smoking history, and underlying diseases (hypertension, diabetes, coronary heart disease). CURB-65: Confusion, Urea, Respiratory rate, Blood pressure, Age ≥ 65 years; CRP: C-reactive protein. *Adjusted for age, gender, body mass index, smoking history, and duration of COPD.

Table 7. Predictive performance of serum CRP and lactate levels for ICU admission

Parameter	CRP alone	Lactate alone	CRP + Lactate combined
AUC (95% CI)	0.835 (95% CI: 0.782-0.888)	0.742 (0.632-0.852)	0.835 (0.742-0.928)
Optimal cutoff value	38.5 mg/L	2.6 mmol/L	0.52*
Sensitivity (%)	72.5	68.9	82.5
Specificity (%)	75.6	71.2	78.9
Youden's index	0.481	0.401	0.614

Note: *The optimal cutoff value for the combined model (CRP + lactate) represents the predicted probability threshold derived from the logistic regression model, ranging from 0 to 1. A cutoff of ≥ 0.52 was used to classify patients at high risk. CRP: C-reactive protein; ICU: Intensive Care Unit.

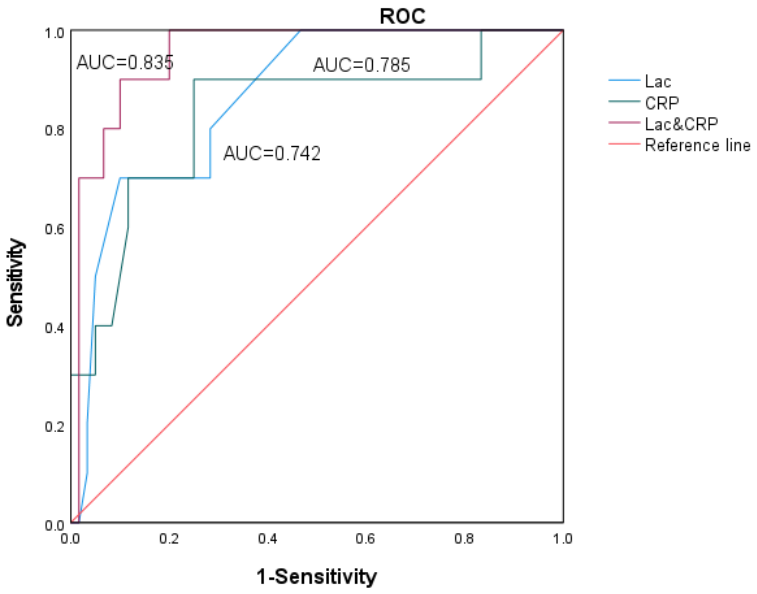

Figure 1. ROC curve analysis for lactate, CRP, and their combination in predicting ICU admission in elderly patients with AECOPD. Notes: CRP: C-reactive protein; Lac: Lactate; ROC: Receiver Operating Characteristic; ICU: Intensive care unit; AECOPD: Acute exacerbation of chronic obstructive pulmonary disease.

0.876, indicating that the model explained approximately 87.6% of the variance in ICU transfer.

To further evaluate model stability and control for overfitting, internal validation was performed using bootstrap resampling with 1,000 iterations. The optimism-corrected R^2 was 0.801, indicating good model stability and no significant overfitting.

Discussions

Chronic obstructive pulmonary disease (COPD) is a chronic respiratory disease with a high incidence in the elderly population. Acute exacerbation represents a key stage in disease progression and is a major cause of hospitalization, disease deterioration, and mortality [11-13]. Acute lower respiratory tract infection (ALRTI) is one of the most common causes of acute exacerbation of elderly COPD patients. The coexistence of COPD exacerbation and ALRTI can significantly worsen pulmonary function, amplify systemic inflammatory response, and increase the risk of adverse clinical outcomes [14, 15]. Studies have shown that the incidence of ALRTI in elderly patients with AECOPD exceeds 60%, and these patients experience significantly longer

hospitalization time, higher ICU transfer rate, and increased mortality compared with those without ALRTI [16]. Therefore, it is of great clinical significance to identify the clinical characteristics, influencing factors, and prognostic biomarkers of AECOPD complicated by ALRTI for early risk identification, treatment optimization, and prognosis improvement.

Previous studies have shown that the occurrence ALRTI in COPD patients is more strongly correlated with immune status and inflammatory activity rather than baseline demographic characteristics [17, 18]. In this study, no significant differences were observed in baseline data such as age, sex, BMI, smoking history, COPD course, lung function (FEV1% pred), and comorbidities (hypertension, diabetes, coronary heart disease) between elderly AECOPD patients with and without ALRTI. These findings are basically consistent with reports, suggesting that the occurrence of ALRTI in this population is not primarily determined by baseline clinical characteristics [19, 20]. Instead, it may be more closely related to systemic inflammatory state, immune function, and metabolic disturbances during acute exacerbation, rather than differences in underlying health status.

Previous studies have demonstrated that abnormal activation of inflammatory response is a core pathophysiological mechanism in AECOPD combined with ALRTI. CRP, as an important acute-phase reactant protein, is a sensitive indicator reflecting the extend of systemic inflammation [21]. The results of this study showed that the CRP level in the ALRTI group was significantly higher than that in the non-ALRTI group, which is consistent with previous findings indicating that ALRTI can enhance the inflammatory response in patients with AECOPD, resulting in a significant elevation in CRP levels [13, 14]. The underlying mechanism may be that following ALRTI, pathogenic microorganisms invade the host and are recognized by immune cells, thereby activating a cascade of inflammatory signaling pathways and stimulating hepatic synthesis and release of a large amount of CRP. CRP activates the complement system by binding to the phosphocholine residues on pathogen surfaces, thereby promoting the clearance of pathogens by phagocytosis. In addition, CRP participates in the release of inflammatory mediators to further amplify the inflammatory response. Similar findings have been reported in previous studies [22].

Furthermore, this study demonstrated that blood lactate levels were significantly higher in the ALRTI group than that in the non-ALRTI group, suggesting a close association between hyperlactatemia and ALRTI in elderly AECOPD patients. Lactate is the end product of anaerobic glycolysis, and under normal circumstances, serum lactate levels are maintained at a relatively low level. When AECOPD is complicated by ALRTI, severely impaired pulmonary function leads to ventilation-perfusion mismatch and hypoxemia, which shifts cellular metabolism toward anaerobic glycolysis and increases lactate production. At the same time, the inflammatory response leads to vasodilation and impairs microcirculatory perfusion, further exacerbating tissue hypoxia and reducing lactate clearance, ultimately resulting in elevated serum lactate levels. These findings are consistent with previous research conclusions [23].

Clinical evidence has confirmed that outcome differences are important indicators for evaluating the clinical impact of ALRTI in elderly patients with AECOPD [24]. In this study, patients in ALRTI group had significantly longer hospitalization time and higher ICU admission rate and 28-day mortality rate compared those in the non-ALRTI group, suggesting a poorer prognosis in elderly patients with AECOPD complicated by ALRTI. The underlying mechanisms may be multifactorial. On one hand, ALRTI aggravates pulmonary inflammatory injury, leading to further decline in lung function and aggravation of respiratory symptoms such as cough, expectoration, and dyspnea. Consequently, prolonged anti-infective therapy and comprehensive supportive care are required to stabilize the condition. On the other hand, severe pulmonary infection can induce systemic inflammatory response syndrome and even progress to multiple organ dysfunction, thereby increasing the risk of ICU transfer and mortality. These findings are consistent with previous studies reporting a significantly increased risk of poor prognosis in patients with AECOPD complicated by ALRTI [25].

Multivariate logistic regression analysis further showed that elevated CRP levels and

hyperlactacidemia were independent risk factors for ALRTI in elderly patients with AECOPD. Mechanistically, elevated CRP reflects an intensified systemic inflammatory response, which may impair immune function, weaken respiratory mucosa defense, and facilitate pathogen invasion, thereby increasing susceptibility to ALRTI. Hyperlactacidemia reflects tissue hypoxia and microcirculation dysfunction. Hypoxia may further damage respiratory epithelial cells, destroy airway barrier integrity, and impair immune cell activity, ultimately increasing the risk of pulmonary infection [26].

In addition, this study found that both CRP and lactate levels were positively correlated with CURB-65 score. As a commonly used index for evaluating disease severity in patients with acute respiratory infection, a higher CURB-65 score is indicative of more severe illness. These findings suggest that higher serum CRP and lactate levels are associated with greater disease severity in infected patients, further supporting their value as important markers reflecting disease severity, in line with previous research conclusions [27].

The development of predictive models has been widely recognized as an effective approach for early identification of poor prognosis in elderly patients with AECOPD [28]. In this study, ROC curve analysis demonstrated that serum CRP and lactate levels had certain predictive value for ICU admission in elderly patients with AECOPD, and their combined application significantly improved predictive performance compared with either marker alone. These findings suggest that the combined detection of CRP and lactate can more accurately identify patients at high risk of poor prognosis. The underlying rationale may be that CRP primarily reflects the intensity of systemic inflammatory response, whereas lactate mainly reflects tissue hypoxia and metabolic dysfunction. These two biomarkers reflect different but complementary aspects of the patient's pathophysiological status. Therefore, their combined detection may provide a more comprehensive evaluation of disease severity, thereby improving the accuracy of prognostic prediction. This is consistent with previous research conclusions [25, 26]. Moreover, internal validation showed good calibration and stability of the predictive model, with good agreement between predicted and observed outcomes, further supporting the reliability of the CRP-lactate-based prediction model. Similar findings have been reported in previous studies [29].

Several limitations should be acknowledged. First, the retrospective, single-center design may have introduced selection bias and information bias due to incomplete or inaccurate medical records, limiting the ability to infer causality. Second, the relatively small sample size and lack of external validation limit the generalizability of our findings to broader populations or other clinical settings. Third, other important inflammatory markers such as procalcitonin (PCT) and interleukin-6 (IL-6) were not included, which may have introduced unmeasured confounding and limited the comprehensiveness of the risk assessment. Fourth, the absence of long-term follow-up data prevented assessment of dynamic biomarker changes and long-term prognosis. Fifth, although standardized diagnostic criteria for ALRTI were applied, diagnostic accuracy remains inherently limited in retrospective analyses. Therefore, prospective, multicenter studies with standardized protocols, larger sample sizes, external validation, and broader panels of biomarkers are warranted to validate and extend our findings.

Conclusion

Serum CRP and lactate levels are significantly elevated in elderly patients with AECOPD complicated by ALRTI and are associated with disease severity and adverse clinical outcomes. The combined assessment of serum CRP and lactate levels demonstrates good predictive value for ICU admission, and may facilitate early identification of high-risk patients in clinical practice.

Disclosure of conflict of interest

None.

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