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CORRELATION ANALYSIS OF SERUM AAG/LDH AND BLa LEVELS WITH THE PROGNOSIS OF SEVERE PNEUMONIA COMPLICATED WITH SHOCK

KORELACIONA ANALIZA SERUMSKIH NIVOA AAG/LDH I BLa SA PROGNOZOM TEŠKE PNEUMONIJE KOMPLIKOVANE ŠOKOM

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Summary

Background: This study aimed to explore the relationships between serum α1-acid glycoprotein (AAG), lactate dehydrogenase (LDH), and blood lactate (BLa) levels and the severity and prognosis of severe pneumonia (SP) complicated with shock in elderly patients to provide useful references for clinical diagnosis and treatment.
Methods: From May 2024 to July 2025, 364 elderly patients with SP combined with shock who were admitted to our hospital composed the SP combined with shock group. Depending on their severity, patients were divided into low-, medium-, and high-risk groups. A good-prognosis group and a bad-prognosis group were subsequently assigned to patients based on follow-up data. An additional 364 elderly patients with SP who did not experience shock and were admitted to our hospital during that time frame were included in the SP group. Following measurements of each research participant's serum levels of AAG, LDH, and BLa, the AAG/LDH ratio was calculated. APACHE II (Acute Physiology and Chronic Health Evaluation II) and CPIS (clinical pulmonary infection) scores, and AAG, LDH, and BLa levels in elderly patients with SP combined with shock were correlated using Spearman correlation

Kratak sadržaj

Uvod: Cilj ove studije je bio da ispita povezanost serumskih nivoa α1-kiselog glikoproteina (AAG), laktat-dehidrogenaze (LDH) i laktata u krvi (BLa) sa težinom bolesti i prognozom kod teške pneumonije (SP) komplikovane šokom kod starijih pacijenata, kako bi se dobile korisne smernice za kliničku dijagnostiku i lečenje.
Metode: Grupu SP sa šokom su činila 364 starija pacijenta sa SP udruženom sa šokom, hospitalizovana u našoj ustanovi u periodu od maja 2024. do jula 2025. Godine. U zavisnosti od težine stanja, pacijenti su podeljeni u grupe niskog, srednjeg i visokog rizika. Na osnovu podataka praćenja, pacijenti su dalje svrstani u grupu sa dobrom prognozom i grupu sa lošom prognozom. Dodatno su u SP grupu uključena 364 starija pacijenta sa SP bez šoka, koji su hospitalizovani u istom periodu. Nakon merenja serumskih nivoa AAG, LDH i BLa kod svih ispitanika, izračunat je odnos AAG/LDH. Spirmanovom korelacionom analizom je ispitana povezanost APACHE II (Acute Physiology and Chronic Health Evaluation II) i CPIS (Clinical Pulmonary Infection Score) skora sa nivoima AAG, LDH i BLa kod starijih pacijenata sa SP udruženom sa šokom. Multivarijantnom

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analysis. Using multivariate logistic regression, the factors influencing progression to high risk and poor prognosis in elderly patients with SP accompanied by shock were investigated. A receiver operating characteristic (ROC) curve was used to assess the predictive power of serum AAG/LDH and BLa for the prognosis of elderly individuals with SP accompanied by shock.

Results: While the SP group's serum LDH level was lower than the SP group's, the SP combined with shock group's serum AAG and BLa levels and AAG/LDH ratios were higher. Each of these variations was statistically significant ($P<0.05$). The low-risk group had 120 patients, the medium-risk group had 158, and the high-risk group had 86. While the low-risk subgroup's serum LDH level was higher than that of the medium-risk and high-risk subgroups ($P<0.05$), the low-risk subgroup's serum AAG levels, BLa levels, AAG/LDH ratios, APACHE II scores, and CPIS scores were lower. The medium-risk subgroup's blood AAG, BLa, AAG/LDH ratio, APACHE II score, and CPIS score were all lower than the high-risk subgroup's. Still, the high-risk subgroup's serum LDH level was greater ($P<0.05$). Spearman correlation analysis revealed a negative correlation ($P<0.05$) between the serum LDH level and the APACHE II score and CPIS score, and a positive correlation ($P<0.05$) between the serum AAG level, BLa level, AAG/LDH ratio, and APACHE II score in elderly patients with SP and shock. There were 94 patients with poor prognoses and 270 with good prognoses. While the good-prognosis group had higher serum LDH levels than the bad-prognosis group, it had lower serum AAG and BLa levels, a lower AAG/LDH ratio, a lower APACHE II score, and a lower CPIS score ($P<0.05$). Multivariate logistic regression analysis showed that elevated blood AAG/LDH and BLa levels were independent risk factors for progression to high-risk and poor prognosis in elderly SP patients with shock ($P<0.05$). In predicting poor prognosis in older patients with SP and shock, the areas under the receiver operating characteristic (ROC) curves for blood AAG/LDH and BLa were 0.841 and 0.823, respectively, according to the ROC analysis. When predicting poor outcome in elderly patients with SP and shock, the combined AUC of AAG/LDH and BLa was 0.934, higher than the AUC of each sign alone ($P<0.05$).

Conclusion: In elderly patients with SP complicated by shock, serum AAG/LDH and BLa levels are abnormal and closely related to disease severity and patient prognosis. The combination of serum AAG/LDH and BLa for predicting the prognosis of elderly patients with SP complicated by shock has relatively high value.

Keywords: severe pneumonia, shock, α1-acid glycoprotein, lactate dehydrogenase, blood lactate, APACHE II score

Rezultati: U poređenju sa SP grupom, grupa SP sa šokom imala je više serumske nivoe AAG i BLa, kao i viši odnos AAG/LDH, dok je nivo LDH bio niži; sve razlike bile su statistički značajne ($P<0,05$). U grupi SP sa šokom, 120 pacijenata je bilo u grupi niskog rizika, 158 u grupi srednjeg, a 86 u grupi visokog rizika. U grupi niskog rizika nivo LDH bio je viši nego u grupama srednjeg i visokog rizika ($P<0,05$), dok su nivoi AAG, BLa, odnos AAG/LDH, APACHE II skor i CPIS skor bili niži. U grupi srednjeg rizika nivoi AAG, BLa, odnos AAG/LDH, APACHE II i CPIS skor bili su niži nego u grupi visokog rizika, dok je nivo LDH u grupi visokog rizika bio viši ($P<0,05$). Spirmanova analiza je pokazala negativnu korelaciju između serumskog nivoa LDH i APACHE II i CPIS skora ($P<0,05$), kao i pozitivnu korelaciju između nivoa AAG, BLa i odnosa AAG/LDH sa APACHE II i CPIS skorom ($P<0,05$). U grupi sa lošom prognozom bilo je 94 pacijenta, a u grupi sa dobrom prognozom 270 pacijenata. Grupa sa dobrom prognozom imala je viši nivo LDH, dok su nivoi AAG, BLa, odnos AAG/LDH, APACHE II i CPIS skor bili niži u odnosu na grupu sa lošom prognozom ($P<0,05$). Multivarijantna logistička regresiona analiza je pokazala da su povišeni nivoi AAG/LDH i BLa nezavisni faktori rizika za progresiju ka visokom riziku i lošoj prognozi kod starijih pacijenata sa SP udruženom sa šokom ($P<0,05$). ROC analiza je pokazala da su AUC vrednosti za AAG/LDH i BLa iznosile 0,841 i 0,823. Kombinovana AUC vrednost AAG/LDH i BLa iznosila je 0,934, što je bilo više u poređenju sa pojedinačnim parametrima ($P<0,05$).

Zaključak: Kod starijih pacijenata sa SP komplikovanom šokom, serumski nivoi AAG/LDH i BLa pokazuju značajne promene koje su usko povezane sa težinom bolesti i prognozom. Kombinovana primena parametara AAG/LDH i BLa ima relativno visoku vrednost u proceni prognoze kod starijih pacijenata sa SP udruženom sa šokom.

Ključne reči: teška pneumonija, šok, α1-kiseli glikoprotein, laktat-dehidrogenaza, laktat u krvi, APACHE II skor

Introduction

Severe pneumonia (SP) is a disease characterized by pulmonary parenchymal inflammation caused by infection and often presents with respiratory symptoms such as breathing difficulties and tachycardia (1–3). Shock is a common complication of SP. Elderly patients with SP combined with shock have decreased organ function and a poor prognosis. Therefore, timely and accurate assessment of a patient's condition and prognosis is particularly important for clinical treatment. An imbalance between proinflammatory and anti-inflammatory responses is a key factor in the progression of SP combined with shock. α1-acid glycoprotein (AAG) participates in various inflammatory responses in the body, can quickly respond to adverse stimuli such as infection and acute organ damage, and is a sensitive inflammatory

marker reflecting the degree of inflammation and tissue damage (4–6). Lactate dehydrogenase (LDH) can reflect the body's immunity and can alleviate inflammatory responses and maintain blood osmotic pressure. The serum AAG/LDH ratio can reflect the severity of SP infection. It can also serve as an effective indicator of capillary leakage (7). Serum blood lactate (BLa) is an indicator of tissue perfusion, and changes in its level are important indicators for evaluating the severity of SP. The level and clearance rate of serum BLa can directly reflect the effectiveness of fluid resuscitation and are important indicators of treatment efficacy (8–10).

However, the clinical value of AAG/LDH and BLa in the prognosis of patients with SP combined with shock remains to be verified. To establish a foundation for the clinical management of patients with SP associated with shock, this study examined relationships between older patients' disease severity and prognosis and serum AAG/LDH and BLa levels.

Materials and Methods

General information

The sample size required for the modelling was calculated via the logistic event number of independent variables (EPV) method. In this study, the predictive model included 4 variables; the incidence of poor prognosis was 25.85%, and the EPV was set at 10. To reduce error, the sample size was increased by 15%, resulting in 364 cases.

From May 2024 to July 2025, 364 elderly patients with SP combined with shock who were admitted to our hospital composed the SP combined with shock group.

Inclusion criteria: (1) met the diagnostic criteria for SP; (2) were aged ≥60 years; (3) met the diagnostic criteria for shock; (4) had normal blood pressure, the systolic blood pressure after this illness was <90 mmHg; or for patients with hypertension, the blood pressure was 30 mmHg lower than usual, and the shock index was greater than 1.0; (5) had not received hormone, immunosuppressant, etc., treatment recently.

Exclusion criteria: (1) congenital pulmonary dysplasia; (2) complicated asthma, bronchiectasis, etc.; (3) complicated benign or malignant tumours; (4) recent history of major surgical operation; (5) complicated important organs such as the liver, kidney, heart diseases; (6) complicated blood diseases; (7) complicated mental abnormalities (11).

The baseline data, including sex, age, BMI, lung infection type, and the presence of underlying illnesses, were comparable and did not show any statistically significant differences ($P>0.05$).

The medical ethics committee approved this investigation (approval number: HKYS-2026-A0270). After learning about the study, each research participant and their family signed an informed consent form.

Serum AAG/LDH and BLa level detection

The levels of serum α1-acid glycoprotein (AAG), lactate dehydrogenase (LDH), and lactic acid (BLa) were detected using standardized procedures. All elderly patients with severe pneumonia complicated with shock included had 4ml of venous blood (vacuum blood collection tube, BD Company, item No. 152278) collected in an empty state on the morning of the first visit. Anticoagulant tubes containing 0.5% heparin sodium (BD Company, item No. 152278) and non-anticoagulant tubes (BD Company, item No. 152278) were injected strictly at a ratio of 1:9. After standing at room temperature for 20 minutes, centrifuge at 3500rpm for 10 minutes (with a centrifugation radius of 8cm) in a Hettich M15R centrifuge (Germany) to separate the hemoserum and plasma. Serum samples were quantitatively detected using the R&D Systems human AAG ELISA Kit (catalogue number MBS510837) and the LDH chemiluminescence detection Kit (catalogue number ECL2051). The operation was strictly carried out in accordance with the instructions. Quality control samples were set for each batch of experiments (intra-batch CV<5%, inter-batch CV<8%). The dynamic changes were evaluated by the AAG/LDH ratio calculation system (homemade Excel formula: AAG/LDH= serum AAG value/serum LDH value). After the anticoagulant plasma samples were centrifuged under the same conditions, the BLa level was measured by the G-6-PD enzyme method, and absorbance was measured at 340 nm using a Thermo Scientific Lactate Procare spectrophotometer (model M200). The calibration curve was plotted based on BD BLa Quality control serum (catalogue number BLD-LAC-500) (range 1.2–15.0 mmol/L, $R^2=0.999$).

All sample tests were conducted independently by trained laboratory technicians. The tests were repeated three times, and the average was taken. Quality control samples were rechecked every four hours. The test data were verified by QC/PC software (version 3.2.1) to ensure compliance with the CLSI EP5-A3 standard. Serum samples should be frozen at -80 °C. Before testing, they should be completely thawed, mixed well, and aliquot into 2 mL centrifuge tubes to avoid repeated freezing and thawing. This method was verified by a pre-experiment (n=30). The detection sensitivity of AAG was 0.1 mg/L, the detection limit of LDH was 1.2 g/L, and the detection error of BLa was less than 8%. It has good specificity and repeatability and can effectively distinguish biomarker differences among groups with different severity and prognosis.

Severity assessment

The Acute Physiology and Chronic Health Evaluation II (APACHE II) score (12) was used to assess the severity of patients with SP combined with shock. It includes three dimensions, namely, age (0–6 points), acute physiology (0–60 points), and chronic health status (2–5 points), totalling 71 points. The APACHE II score was used to classify patients into low-risk (sum ≤10 points), moderate-risk (sum > 0 to 20 points), and high-risk (sum >20 points) subgroups.

Clinical Pulmonary Infection Score (CPIS)

The CPIS scale consists of 6 items (each scored 0-2), yielding a total score of 0–12. A higher score indicates a more severe pulmonary infection.

Follow-up investigation

For patients in the SP-shock group, follow-up was conducted for 28 days after admission. The remaining patients were placed in the good prognosis group, while those who passed away during this time were placed in the poor prognosis group.

Observation indicators

(1) The levels of serum AAG/LDH and BLa in the SP combined with shock group and the SP group were compared. (2) The levels of serum AAG/LDH, BLa, the APACHE II score, and the CPIS score were compared across patients with different disease severities in the SP combined with shock group. (3) The APACHE II score, CPIS score, and serum AAG/LDH and BLa levels were examined for associations. (4) In the SP combined with shock group, the blood AAG/LDH and BLa levels in patients with various prognoses were compared. (5) Examine how the severity and prognosis of SP with shock are related to serum AAG/LDH and BLa. (6) Examine the prognostic value of BLa and serum AAG/LDH for the prognosis of elderly individuals with shock and SP.

Statistical analysis

SPSS 27.0 statistical software was used to handle and evaluate the data. The formula $\bar{x}\pm s$ is used to represent quantitative data that has a normal distribution. The independent-samples t-test was used to compare two groups, the one-way analysis of variance was used to compare multiple groups, and the least significant difference (LSD) test was used to compare two groups. Count statistics are displayed as percentages or counts, and the χ^2 test was used to compare groups. The relationships between serum AAG/LDH and BLa levels and the APACHE II and CPIS scores in older patients with SP and shock were examined using Spearman correlation analysis. The determinants of progression to high risk and poor prognosis in older patients with SP exacerbated by shock were determined using a multivariate logistic regression analysis. Before the regression analysis, collinearity among the included independent variables was assessed, and multicollinearity was avoided by confirming that all tolerances were greater than 0.1 and all variance inflation factors (VIFs) were less than 5. The prognostic ability of serum AAG/LDH and BLa in elderly patients with SP exacerbated by shock was examined using a receiver operating characteristic (ROC) curve. The area under the curve (AUC) was compared via the DeLong test. An AUC<0.5 indicated no predictive value, 0.5–< 0.7 indicated a low predictive value, 0.7–0.9 indicated a certain predictive value, and >0.9 indicated a high predictive value.

Results

Comparison of the serum AAG and BLa levels and the AAG/LDH ratio between the SP combined with shock group and the SP group

The serum AAG, BLa, and AAG/LDH levels in the SP combined with shock group were greater than those in the SP group. In contrast, the serum LDH level was lower than that in the SP group. The differences were statistically significant (P<0.05), see *Table I*.

Table I Comparison of serum AAG, BLa levels, and AAG/LDH between the SP combined shock group and the SP group.

Group	n	AAG (mg/L)	LDH (g/L)	AAG/LDH	BLa (mmol/L)
SP combined with the shock group	364	105.73±27.25	27.12±5.19	3.82±1.15	6.10±2.05
SP group	364	87.66±19.59	28.96±4.30	3.06±0.88	4.65±1.20
t		7.276	-3.475	8.252	8.767
P		<0.001	0.001	<0.001	<0.001

Comparison of the baseline data of patients with SP combined with shock of different severity levels

According to the APACHE II score data, there were 120 patients in the low-risk category, 158 in the medium-risk subgroup, and 86 in the high-risk cohort. The low-risk subgroup included 54 males and 66 females; the ages ranged from 61–79 years, with an average of (69.37±4.14) years; the BMI ranged from 23–27 kg/m^2, with an average of (24.89±0.98) kg/m^2; the medium-risk subgroup included 82 males and 76 females; the ages ranged from 60–78 years, with an average of (68.72±4.09) years; the BMI ranged from 23–26 kg/m^2, with an average of (24.68±1.04) kg/m^2; the high-risk subgroup included 44 males and 42 females; the ages ranged from 62–78 years, with an average of (69.96±4.16) years; and the BMI ranged from 22–27 kg/m^2, with an average of (24.73±0.92) kg/m^2. Age, BMI, and sex did not differ significantly amongst the three groups ($p > 0.05$).

Comparison of serum AAG and BLa levels, the AAG/LDH ratio, the APACHE II score, and the CPIS score in patients with SP combined with shock of different severity levels

The serum AAG level, BLa level, AAG/LDH ratio, APACHE II score, and CPIS score in the low-risk subgroup were lower than those in the medium- and high-risk subgroups. The serum LDH level was significantly greater than that of the medium-risk and high-risk subgroups ($P<0.05$). The serum AAG level, BLa level, AAG/LDH ratio, APACHE II score, and CPIS score of the medium-risk subgroup were significantly lower than those of the high-risk subgroup. The serum LDH level was significantly higher than that of the high-risk subgroup ($P<0.05$; see *Table II*).

Table II Comparison of serum AAG, BLa levels, AAG/LDH, APACHE II score, and CPIS score in patients with SP combined with shock of different severity levels ($\bar{x}\pm s$).

Group	n	AAG (mg/L)	LDH (g/L)	AAG/LDH	BLa (mmol/L)	APACHEI score (points)	CPIS score (points)
Low-risk subgroup	120	66.78±18.23	29.87±3.64	2.27±0.32	5.32±1.55	7.24±1.06	3.98±0.78
Medium risk subgroup	158	112.86±31.45	27.19±3.25	4.18±0.54	6.25±1.67	16.28±1.77	5.71±1.06
High-risk subgroup	86	145.84±35.06	23.61±2.17	6.19±0.50	7.16±1.27	23.97±1.54	8.20±1.35
F		99.248	48.081	809.847	16.635	1633.383	221.245
P		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Table III Correlation between serum AAG, BLa levels, AAG/LDH, and APACHE II score, CPIS score in elderly SP patients with shock.

Indicator	APACHE II rating		CPIS rating	
	r	P	r	P
AAG	0.625	<0.001	0.590	<0.001
LDH	-0.522	<0.001	-0.554	<0.001
AAG/LDH	0.641	<0.001	0.704	<0.001
BLa	0.634	<0.001	0.675	<0.001

Table IV Comparison of serum AAG, BLa levels, and AAG/LDH in SP patients with different prognoses and shock ($\bar{x}\pm s$).

Group	n	AAG (mg/L)	LDH (g/L)	AAG/LDH	BLa (mmol/L)
Good prognosis group	270	104.78±30.10	28.62±4.15	3.68±1.13	5.55±1.22
Poor prognosis group	94	152.81±41.35	22.30±3.53	6.86±1.29	8.09±2.07
t		-8.518	9.391	-16.420	-9.887
P		<0.001	<0.001	<0.001	<0.001

Table V Multivariate logistic regression analysis of factors influencing the progression of high risk in elderly sp patients with shock.

Factor	Assignment	β	Wald x^2	SE	P	OR	OR 95%CI	
							Lower limit	Upper limit
AAG/LDH	Original value input	0.225	17.492	0.056	<0.05	1.241	1.026	1.526
BLa	Original value input	0.175	17.502	0.044	<0.05	1.180	1.014	1.397

Correlations between serum AAG, LDH, and BLa levels and AAG/LDH and the APACHE II score and CPIS score in elderly patients with SP complicated with shock

Spearman correlation analysis revealed that the serum AAG and BLa levels and the AAG/LDH ratio in elderly patients with SP complicated with shock were positively correlated with the APACHE II score and CPIS score ($P<0.05$), whereas the serum LDH level was negatively correlated with the APACHE II score and CPIS score ($P<0.05$), see *Table III*.

Comparison of the baseline data of patients with SP combined with shock with different prognoses

According to the 28-day follow-up, 270 patients were in the favourable-prognosis group, whereas 94 were in the poor-prognosis group. The group with a good prognosis comprised 118 females and 152 males, with an average age of 69.14±4.05 years (range, 61–77 years), and a BMI of 22–26 kg/m^2, with an average of 24.69±0.90 kg/m^2. The poor prognosis group included 50 males and 44 females, the age ranged from 60–79 years, with an average of 69.64±4.16 years; and the BMI ranged from 22–27 kg/m^2, with an average of 24.96±1.04 kg/m^2. The groups with favourable and poor prognoses did not differ significantly in age, sex, or BMI ($P>0.05$).

Comparison of serum AAG and BLa levels and AAG/LDH in patients with SP combined with shock with different prognoses

The serum AAG, BLa, and AAG/LDH levels in the good prognosis group were lower than those in the poor prognosis group, and the serum LDH level was higher than that in the poor prognosis group. The differences were statistically significant ($P<0.05$), see *Table IV*.

Multivariate logistic regression analysis of the factors influencing the severity of shock in elderly patients with SP

Taking the severity of shock in elderly patients with SP (low and moderate risk =0, high risk =1) as the dependent variable and serum AAG/LDH and BLa as independent variables, a multivariate logistic regression analysis was conducted (AAG and LDH were excluded because of their collinearity with AAG/LDH). The results revealed that elevated serum AAG/LDH and BLa were independent risk factors for the progression of elderly patients with SP and shock to a high-risk state ($P<0.05$), see *Table V.*

Multivariate logistic regression analysis of the influencing factors for poor prognosis in elderly patients with SP complicated by shock

Taking the prognosis of elderly patients with SP complicated by shock (prognosis good =0, prognosis poor =1) as the dependent variable and serum AAG/LDH and BLa as independent variables, a multivariate logistic regression analysis was conducted (AAG, LDH, and the relationship between AAG/LDH are collinear, so AAG and LDH were excluded). The results revealed that increases in serum AAG/LDH and BLa were independent risk factors for poor prognosis in elderly patients with SP complicated by shock ($P<0.05$), see *Table VI*.

Table VI Multivariate logistic regression analysis of factors affecting poor prognosis in elderly SP patients with shock.

Factor	assignment	β	Wald x^2	SE	P	OR	OR 95%CI	
							Lower limit	Upper limit
AAG/LDH	Original value input	0.202	6.346	0.086	<0.05	1.235	1.028	1.485
BLa	Original value input	0.279	13.516	0.078	<0.05	1.310	1.096	1.581

Table VII Analysis of the predictive efficacy of serum AAG/LDH and BLa for poor prognosis in elderly SP patients with shock.

Indicator	AUC	AUC 95%CI	Best Truncation Value	Sensitivity (%)	Specificity (%)	Youden index	P
AAG/LDH	0.841	0.754~0.911	6.64	80.99	80.36	0.616	<0.05
BLa	0.823	0.723~0.899	7.69 mmol/L	71.46	81.90	0.537	<0.05
AAG/LDH+BLa	0.934	0.856~0.978	–	80.98	91.83	0.721	<0.05

Analysis of the predictive efficacy of serum AAG/LDH and BLa for poor prognosis in elderly patients with SP and shock

The ROC curve was created using blood AAG/LDH and BLa levels as test factors and the prognosis of elderly patients with SP and shock as the dependent variable (bad prognosis =1, excellent prognosis =0). The AUCs for serum AAG/LDH and BLa in predicting a poor prognosis in elderly patients with SP and shock were 0.841 and 0.823, respectively. The AUC of AAG/LDH combined with BLa for predicting poor prognosis in elderly patients with SP and shock was 0.934, which was greater than the AUCs of each indicator alone ($P<0.05$; see *Table VII*).

Discussion

Owing to declines in organ function and poor overall condition in the elderly population, along with reduced respiratory and immune function, these individuals are more susceptible to pathogen infections and prone to developing sepsis (11–13). Shock often occurs because the inflammatory response in the SP lung tissue becomes more severe, triggering uncontrolled inflammation and leading to a severe systemic inflammatory response (14–16). The progression of SP combined with shock is rapid, and there are currently no specific treatment methods. The prognosis is poor. Therefore, accurately assessing patient condition and objectively predicting prognosis can help clinicians adjust treatment plans and improve treatment outcomes.

AAG is an important indicator of whether an organism has been infected and can directly reflect the degree of inflammation in the body (17, 18). LDH can participate in blood circulation and help maintain plasma osmotic pressure within the body. When the body undergoes a strong inflammatory response that affects liver function, its level significantly decreases. Thus, the immune-inflammatory status of the organism can be reflected in the AAG/LDH ratio (19–21). The medium-risk and high-risk groupings had higher serum AAG/LDH ratios than the low-risk cohort. Additionally, in the SP combined with shock group, the serum AAG/LDH ratio showed a positive correlation with both the APACHE II score and CPIS ($P<0.05$), consistent with other research findings and suggesting that the AAG/LDH ratio plays a role in the development of SP. When there is an inflammatory response in the body of SP patients and damage to lung tissue, the AAG level increases rapidly; at the same time, the body of SP patients is severely infected, which inhibits the synthesis of LDH, and various inflammatory factors damage liver cells to some extent, thereby reducing the synthesis of LDH (22–25).

BLa is an important indicator reflecting tissue perfusion (26–28). The low-risk grouping had a lower BLa level than the medium-risk and high-risk subgroups, according to the study's findings. The BLa level increases as the severity of SP combined with shock worsens. These findings may be due to the reduced pulmonary ventilation function in patients with SP combined with shock, decreased ventilation volume, and increased hypoxia, which easily leads to insufficient tissue perfusion, increased anaerobic glycolysis, mitochondrial dysfunction, and increased BLa secretion, thereby further reducing tissue ischemia and hypoxia and forming a vicious cycle (29–31). According to the study's findings, the APACHE II and CPIS scores of the SP combined with shock group showed a positive correlation with the BLa level ($P<0.05$), and the BLa level was higher in the SP combined with shock group than in the SP group.

The goal of this investigation was to analyse the predictive significance of serum AAG/LDH and BLa levels in older individuals with SP exacerbated by shock. Despite higher LDH levels, the good-prognosis group's blood levels of AAG/LDH, AAG, and BLa were lower than those of the poor-prognosis group, according to the results. According to multivariate logistic regression analysis, blood AAG/LDH and BLa levels were independent risk factors for the progression of the illness to high risk and poor prognosis in elderly patients with SP that was made worse by shock. The serum AAG/LDH and BLa levels are highly important for evaluating the prognosis of elderly patients with SP complicated by shock. The study's ROC curve analysis results showed that the combined prediction of AAG/LDH and BLa for the prognosis of elderly patients with SP exacerbated by shock had a higher predictive value than the detection of AAG/LDH and BLa alone, suggesting that the serum AAG/LDH and BLa can be used as reference indicators for evaluating the prognosis of elderly patients with SP complicated by shock and that the combined detection of the two has greater predictive efficacy.

Conclusion

The levels of serum AAG/LDH and BLa are closely related to the severity and poor prognosis of elderly patients with SP combined with shock. The combined detection of serum AAG/LDH and BLa is expected to serve as a new approach for predicting the prognosis of elderly patients with SP and shock, with high predictive efficacy.

Authors' contribution

Jie Yang and Jia Li made equal contributions to this research work.

Conflict of interest statement

All the authors declare that they have no conflict of interest in this work.

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