Research Square

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Diagnostic Value of sIL-2R, TNF-α and PCT for Sepsis Infection in Patients with Closed Abdominal Injury Complicated with Severe Multiple Abdominal Injuries

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Abstract

Objective: To evaluate the diagnostic value of soluble interleukin-2 receptor (sIL-2R), tumor necrosis factor-α (TNF-α), procalcitonin (PCT) and combined detection for sepsis infection in patients with closed abdominal injury complicated with severe multiple abdominal injuries.

Patients and Methods: 140 patients with closed abdominal injury complicated with severe multiple abdominal injuries who were diagnosed and treated in 2015 to 2020, were divided into sepsis group (n = 70), and infection group (n = 70).

Results: The levels of sIL-2R, TNF-α and PCT in sepsis group were higher than those in infection group ($P < 0.05$). ROC curve showed that the AUC values of sIL-2R, TNF-α, PCT and sIL-2R+TNF-a+PCT were 0.827, 0.781, 0.821 and 0.846, respectively, which were higher than those of WBC, CRP, SAA, and IL-6. AUC of the three combined tests was higher than that of TNF-α, and the difference was statistically significant ($P < 0.05$). There was no significant difference in AUC between sIL-2R and TNF-α, sIL-2R and PCT, TNF-α and PCT, three combined tests and sIL-2R, three combined tests and PCT ($P > 0.05$). When the median was used as the cut point, the corrected sIL-2R, TNF-α, PCT high level group was not better than the low level group in the risk of sepsis ($P >0.05$). When the four groups were classified by using quantile as cut point, the OR risk values of the high level of TNF-α and PCT (Q4) and the low level of PCT (Q1) after correction were 7.991 and 21.76, respectively, with statistical significance ($P < 0.05$).

Conclusions: The detection of sIL-2R, TNF-α and PCT has a good value in the diagnosis for sepsis infection in patients with closed abdominal injury complicated with severe multiple abdominal injuries. The high concentrations of PCT and TNF-α can be used as predictors of septic infection risk.

Introduction

Closed abdominal injury with severe multiple traumas is characterized by complex and hidden conditions, and most patients are accompanied by injuries to the brain, chest and limbs, etc [1]. The prognosis of closed abdominal injury depends on the presence or absence of visceral injury, which is characterized by persistent vomiting, nausea, abdominal pain, internal bleeding, and peritoneal irritation in terms of clinical symptoms [2]. Multiple injuries refer to more than or equal to two injuries to human organs or anatomical sites under the same pathogenic causes. For patients with closed abdominal injuries accompanied by severe multiple injuries, besides abdominal injuries, patients are often accompanied by fractures, brain injuries, etc [3]. The accompanying multiple injuries may conceal the actual physical signs of patients, thus increasing the difficulty of clinical diagnosis. In the case of closed abdominal injury combined with multiple systemic injuries, the patient's injuries are severe and complex, including shock, sepsis, coma, dyspnea and other symptoms in the early stage, which makes the diagnosis and treatment more difficult and leads to higher mortality [4].

Sepsis is a systemic inflammatory response syndrome caused by severe infection. The main pathogens of sepsis are bacteria, followed by fungi, viruses and parasites [5]. Sepsis is a major cause of death

worldwide, with a high incidence, which can cause damage to important organs such as heart, lung and kidney. In severe cases, it can lead to organ failure, tissue damage and even death [6, 7]. Sepsis has been reported to cause about 25–50% of deaths in the United States, Europe and South America [8]. Blood culture is considered as the “golden criteria” for diagnosing septic infection [9], because blood culture can isolate pathogenic bacteria, which is conducive to further antimicrobial susceptibility test and reasonable selection of antimicrobial agents. However, it has been reported [10] that only half of the patients suspected of sepsis were found to be infected by pathogenic bacteria, and there were also problems such as contamination of normal skin bacteria and long culture time leading to inability to obtain results in time [11]. Therefore, the early diagnosis of sepsis and targeted treatment within a few hours of the first diagnosis are extremely important [12]. Although the diagnostic criteria for sepsis have been established, the early diagnosis of sepsis is still difficult due to the unclear primary infectious focus and the vague definition of sepsis syndrome [13].

Soluble interleukin 2 receptor (sIL-2R) is a nonspecific indicator produced by lymphocytes under conditions such as malignant tumors and infection, which can reflect diseases related to lymphocyte activation and is also a marker of the activation of the immune system [14]. Tumor necrosis factor-α (TNF-α) is a major pro-inflammatory cytokine, which plays a key role in antimicrobial and anti-inflammatory responses through mechanisms such as activation of white blood cells, cell proliferation, differentiation and apoptosis of lymphocytes [15, 16]. A large number of cytokines are produced in the process of infection, among which TNF-a plays a powerful immune regulatory role in the host immune response [17]. Serum procalcitonin (PCT) is a kind of calcitonin propeptide that is elevated during inflammation and infection,and it is also considered as a diagnostic marker for early infection [18]. Based on the third international consensus criteria as diagnostic criteria [19], this study intends to evaluate the diagnostic value of sIL-2R, TNF-α, PCT and their combined detection in sepsis patients with closed abdominal injury complicated with severe multiple abdominal injuries. The optimal threshold value of infection in patients with sepsis was determined in this study, and the influence of sIL-2R, TNF-α, and PCT in patients with sepsis was evaluated, which also provides reference for the early diagnosis of sepsis in patients with closed abdominal injury complicated with severe multiple abdominal injuries.

Materials And Methods

2.1 Patients and clinical information

We retrospectively analyzed 140 patients with closed abdominal injury complicated with severe multiple abdominal injuries treated in 903rd Hospital of PLA, the Fifth People's Hospital of Jiaozuo City, the First Affiliated Hospital of Henan University of technology, the first people's Hospital of Yancheng City, and the Sixth People's Hospital of Yancheng City from 2015 to 2020, including 70 patients with sepsis (sepsis group), and 70 patients without sepsis but with local inflammatory infection (infection group). All the medical records were confirmed by clinical symptoms, B-ultrasound, X-ray films, laboratory and so on. The location of abdominal injury was 13 cases of pancreas, 15 cases of duodenum, 32 cases of colon, 13 cases of liver, 19 cases of small intestine, 48 cases of spleen, 98 cases of multiple organ injury and 42

cases of single organ injury. The diagnosis of sepsis was based on the third international consensus diagnostic criteria for sepsis and septic shock 3.0 published in 2016. The exclusion criteria were as follows: patients with tumor, patients with blood diseases, patients with organ transplantation, patients with missing clinical and laboratory data, and patients with immune deficiency.

The baseline clinical data of 140 enrolled patients were collected from medical records, including age, gender, sIL-2R, TNF-α, PCT, WBC, CRP, SAA, IL-6, acute physiology and chronic health assessment (APACHE Ⅱ). All specimens were enrolled after obtaining informed consent of the patients or their family and the written informed consent from the participants were obtained. The study was approved by the Ethics Committees of the 903rd Hospital of PLA (Approval nos. PLA-117-20160518).

2.2 Statistical analysis

Statistical analyses were performed with SPSS 25.0 software (IBM). Continuous data were presented as means ± standard deviations. Measurement data between the two groups were conducted using independent samples T-test. Numeration data were analyzed by C2-test. The variables in line with non-normal distribution were expressed as median (p25 and p75) and were compared using nonparametric Mann-Whitney U-test. The software GraphPad Prism was used to make ROC curves of each index and its combined index to determine the sensitivity, specificity, optimal cut-off value, Youden index, negative predictive value (NPV) and positive predictive value (PPV) of each index in patients infected with sepsis. The area under the curve (AUC) was used to judge the accuracy of the test. The combined predictors of sIL-2R, TNF-α and PCT were calculated by binary Logistic regression analysis. The areas under the ROC curves (AUCs) were compared between each index using Z-test. Spearman's rank correlation coefficient was used to analyze the correlation between the levels of IL-2R, TNF-α, PCT and other laboratory parameters and APACH Ⅱ. Binary Logistic regression analysis was used to evaluate the risk of sIL-2R, TNF-α, and PCT levels in sepsis, using median (P50) and quartile (P25, P50, P75) as cut points, respectively. Binary Logistic regression analysis was used to calculate the values of single-factor and multi-factor adjusted odds ratios (AOR) and 95% confidence intervals (CI) based on maximum likelihood estimates. $P < 0.05$ was considered statistically significant.

Results

3.1 Clinical baseline of enrolled subjects in both infection group and sepsis group

Table 1 showed the clinical baseline of enrolled 140 patients with closed abdominal injury complicated with severe multiple abdominal injuries. There was no statistical significance in gender and age distribution between infection group and sepsis group ($P > 0.05$). The scores of WBC, CRP, SAA, IL-6 and APACHE Ⅱ in the sepsis group were all higher than those in the infection group, with statistical significance ($P < 0.05$).

Table 1
Characteristics of the enrolled patients

Variables	infection group (n = 70)	sepsis group (n = 70)	*P* value
Gender(F/M)	38/32	41/29	0.609
Age(y)	72(63,80)	78(65,85)	0.099
Location of abdominal injury			0.994
pancreas	6	7	
duodenum	6	9	
colon	13	19	
liver	5	8	
small intestine	9	10	
spleen	20	28	
WBC($\times 10^9$/L)	12.22(9.44,15.88)	17.50(12.93,19.74)	< 0.001
CRP(mg/L)	55.28(25.23,91.31)	133.59(85.20,225.50)	< 0.001
SAA(mg/L)	76.54(31.18,102.62)	124.61(53.78,187.47)	0.001
IL-6(pg/mL)	10.50(4.34,29.93)	31.75(17.93,113.20)	< 0.001
APACHE-Ⅱ	9.85(7.66,13.49)	18.85(12.69,23.61)	< 0.001

3.2 Expression levels of sIL-2R, TNF-α and PCT in two groups of subjects

The level of sIL-2R in the sepsis group was higher than that in the infection group, and the difference was statistically significant (Z=-6.668, *P*< 0.001), as shown in Fig. 1A. The levels of TNF-α in the sepsis group were higher than those in the infection group, and the difference was statistically significant (Z=-5.728, *P* < 0.001), as shown in Fig. 1B. The levels of PCT in the sepsis group were higher than those in the infection group, and the difference was also statistically significant (Z=-6.560, *P*< 0.001), as shown in Fig. 1C.

3.3 Correlation between sIL-2R, TNF-α, PCT and other commonly used laboratory infection indicators in two groups

The level of sIL-2R was positively correlated with CRP, SAA and IL-6 in the infection group (r = 0.396, *P*< 0.001; r = 0.314, *P*< 0.008; r = 0.262, *P*= 0.028), there was no correlation between sIL-2R level and WBC, APACHE Ⅱ (r = 0.207, *P*< 0.085; r = 0.233, *P*= 0.053). The levels of sIL-2R in sepsis group were positively correlated with WBC, CRP, SAA, IL-6 and APACHE Ⅱ (r = 0.387, *P*= 0.001; r = 0.248, *P*= 0.038; r = 0.402, *P*= 0.001; r = 0.532, *P*< 0.001; r = 0.261, *P*= 0.029), which is shown in Fig. 2.

TNF-α level in the infected group was positively correlated with IL-6 (r = 0.247, *P* = 0.039), while TNF-a level in the infected group was not correlated with WBC, CRP, SAA, APACHE Ⅱ (r = 0.026, *P* = 0.832; r = 0.208, *P* = 0.083; r = 0.215, *P* = 0.074; r = 0.105, *P* = 0.386). TNF-α level was positively correlated with WBC, SAA and IL-6 in sepsis group (r = 0.320, *P* = 0.007; r = 0.379, *P* = 0.001; r = 0.401, *P* = 0.001), and there was no correlation between TNF-α level and CRP and APACHE Ⅱ in sepsis group (r = 0.103, *P* = 0.395; r = 0.161, *P* = 0.184), as shown in Fig. 3.

PCT level in the infected group was positively correlated with CRP (r = 0.360, *P* = 0.002), while PCT level in the infected group was not correlated with WBC, SAA, IL-6, APACHE Ⅱ (r = 0.031, *P* = 0.802; r = 0.113, *P* = 0.350; r = 0.147, *P* = 0.223; r = 0.133, *P* = 0.273). PCT level in the sepsis group was positively correlated with IL-6 (r = 0.289, *P* = 0.015), while PCT level in the sepsis group was not correlated with WBC, CRP, SAA, APACHE Ⅱ (r = 0.225, *P* = 0.061; r = 0.163, *P* = 0.178; r = 0.220, *P* = 0.067; r = 0.217, *P* = 0.071), which is shown in Fig. 4.

3.4 The diagnostic performance of laboratory infection indicators in subjects with sepsis and infection

Infection group Y (sepsis group = 1, infection group = 0) was used as the dependent variable, sIL-2R(X1), TNF-α(X2), PCT(X3) were used as the independent variables. The joint predictors of sIL-2R, TNF-α and PCT were calculated by binary Logistic regression analysis, and the regression equation was Y=-2.343 + 0.000X1 + 0.026X2 + 0.364X3. The joint predictors were used as three joint test indexes to analyze the results.

The software GraphPad Prism was used to make the ROC curves of each index and the combined test, as shown in Fig. 5(A-H). When AUC value is 0.712 and cutoff value is 15.46×10^9/L, sensitivity and specificity are 65.71% and 74.29%, NPV and PPV are 68.4% and 71.9%, respectively. When the AUC value of CRP detection is 0.766 and the cutoff value is 85.47 mg/L, the sensitivity and specificity are 75.71% and 72.86%, NPV and PPV are 75.0% and 73.6%, respectively. When the AUC value is 0.666 and the cutoff value is 123.21 mg/L, the sensitivity and specificity are 51.43% and 84.29%, NPV and PPV are 63.4% and 76.6%, respectively. When the AUC value of IL-6 detection is 0.735 and the cutoff value is 9.9 pg/mL, the sensitivity and specificity are 88.57% and 50.00%, NPV and PPV are 81.4% and 63.9%, respectively. When the AUC value of sIL-2R detection is 0.827 and the cutoff value is 1384 U/mL, the sensitivity and specificity are 70.00%, 88.57%, NPV and PPV are 74.7% and 86.0%, respectively. When the AUC value of TNF-α detection is 0.781 and the cutoff value is 14.00 pg/mL, the sensitivity and specificity are 80.00% and 68.57%, NPV and PPV are 77.4% and 71.8%, respectively. When the AUC value of PCT is 0.821 and the cutoff value is 4.35 ng/mL, the sensitivity and specificity are 68.57% and 91.43%, NPV and PPV are 74.4% and 88.9%, respectively. When the AUC value of sIL-2R + TNF-α + PCT was 0.846, and the cutoff value was 0.70, the sensitivity and specificity were 70.00% and 95.71%, NPV and PPV were 76.1% and 94.2% respectively, which is shown in Table 2.

Table 2
The diagnostic performance of laboratory infection indicators in subjects with sepsis and infection

Variables	Youden index	Cutoff	AUC	Sensitivity	Specificity	AUC 95%CI	NPV(%)	PPV(%)
WBC	0.400	15.46	0.712	65.71	74.29	0.629–0.785	68.4	71.9
CRP	0.486	85.47	0.766	75.71	72.86	0.687–0.833	75.0	73.6
SAA	0.357	123.21	0.666	51.43	84.29	0.581–0.743	63.4	76.6
IL-6	0.386	9.90	0.735	88.57	50.00	0.654–0.806	81.4	63.9
IL-2R	0.586	1384.00	0.827	70.00	88.57	0.753–0.885	74.7	86.0
TNF-α	0.486	14.00	0.781	80.00	68.57	0.703–0.846	77.4	71.8
PCT	0.600	4.35	0.821	68.57	91.43	0.748–0.881	74.4	88.9
sIL-2R + TNF-α + PCT	0.657	0.70	0.846	70.00	95.71	0.775–0.901	76.1	94.2

According to the data in Table 2, the combination of sIL-2R, TNF-α, PCT and sIL-2R + TNF-a + PCT had higher AUC values and better diagnostic performance. MedCalc software was used to compare the AUC of sIL-2R, TNF-a, PCT and sIL-2R + TNF-α + PCT. The AUC of sIL-2R and TNF-α, sIL-2R and PCT, TNF-α and PCT were compared. There was no statistically significant difference ($P > 0.05$), and there was no statistically significant difference in AUC between sIL-2R and PCT test ($P > 0.05$). The AUC of the combined test was greater than that of TNF-α, and the difference was statistically significant ($P < 0.05$), as shown in Table 3.

Table 3
Comparison of AUC areas for sIL-2R, TNF-α, PCT and sIL-2R + TNF-α + PCT combined assays

Variables	*Z* value	*P* value
Combination of sIL-2R	0.851	0.395
Combination of TNF-α	2.355	0.019
Combination of PCT	1.160	0.246
sIL-2R and TNF-α	1.386	0.166
sIL-2R and PCT	0.162	0.871
TNF-α and PCT	1.021	0.307

3.5 Risk assessment of sIL-2R, TNF-α, and PCT in predicting sepsis of patients with closed abdominal injury complicated with severe multiple abdominal injuries

Binary Logistic regression analysis was used to evaluate the risk of sIL-2R, TNF-α, and PCT levels in sepsis group. The median cut-off point (two classifications) and the quartile (P25, P50, P75) were evaluated as cut-off points (four classifications). First, patients were divided into low-level group and high-level group according to the median of sIL-2R (1087 U/mL), TNF-α (18.95 pg/mL), and PCT (1.815 ng/mL). Compared with low sIL-2R, the risk of sepsis in patients with high sIL-2R was 11.391 (95% CL, 5.175–25.072) ($P < 0.05$), and the adjusted OR value was 0.489 (95% CL,0.103–2.321) ($P > 0.05$). Compared with low TNF-α, the risk of sepsis in patients with high TNF-α levels was 7.205 (95% CL, 3.420-15.177) ($P < 0.05$), and the adjusted OR was 1.624 (95% CL, 0.531–4.970) ($P > 0.05$). And compared with low PCT, the risk of sepsis in patients with high PCT was 8.346 (3.911–17.810) ($P < 0.05$), and the adjusted OR value was 2.300 (95%CL, 0.812–6.516) ($P > 0.05$), which can be seen from Fig. 6 and Fig. 7.

Secondly, according to the quartile value of sIL-2R (Q1 < 740, 740 ≤ Q2 < 1087,1087 ≤ Q3 < 2124, 2124 ≤ Q4), TNF-α (Q1 < 9.8725, 9.8725 ≤ Q2 18.95, 18.95 ≤ Q3 < 39.4, 39.4 ≤ Q4), PCT (Q1 < 0.5925, 0.5925 ≤ Q2 < 1.815, 1.815 ≤ Q3 < 6.67, 6.67 ≤ Q4), the patients were divided into Q1 group, Q2 group, Q3 group and Q4 group from low to high levels. Compared with the lowest sIL-2R level group (Q1), the OR value of sepsis risk in Q2, Q3 and Q4 groups was 1.000 (0.328–3.052), 6.469 (2.256–18.548) and 26.156 (7.083–96.593) respectively. The OR values after correction were 0.854 (0.224–3.253), 0.403 (0.070–2.335) and 0.681 (0.074–6.262) respectively. Compared with the lowest TNF-α level group (Q1), the OR value of sepsis risk in Q2, Q3 and Q4 groups were 2.087 (0.707–6.165), 5.333(1.839–15.471) and 31.000 (8.195-117.272) respectively. And the OR values after correction were 1.098 (0.275–4.387), 0.836 (0.193–3.617), and 7.991 (1.274–50.108). Compared with the lowest PCT level group (Q1), the OR value of sepsis risk in Q2, Q3 and Q4 groups were 1.000 (0.342–2.921), 3.059 (1.117–8.373) and 98.222 (11.694-824.999) respectively. At the same time, the corrected OR values were 1.013 (0.260–3.949), 0.916 (0.213–3.942) and 21.760 (2.095-226.008), as shown in Fig. 8 and Fig. 9.

Discussion

As an important complication of closed abdominal injury and severe multiple abdominal injuries, sepsis is a complex disease caused by the body's dysfunctional response to infection, and is associated with acute organ dysfunction and a high risk of death [20, 21]. Sepsis can lead to a global public health emergency, affecting millions of people worldwide and being one of the largest causes of death in the world [22]. What plays an essential role in the treatment of sepsis is the early removal of infected lesions and the use of antibiotics as quickly and accurately as possible [23]. Mortality was significantly increased for each hour of delay in antibiotic administration [24, 25], and the delay in antibiotic administration was associated with prolonged length of hospital stay, severity of organ dysfunction and adverse clinical outcomes [26]. However, for all patients with suspected sepsis, antibiotics given within one hour will lead to unreasonable use of antibiotics and increase of bacterial resistance [27–29]. Therefore, early identification and diagnosis of sepsis patients have become particularly important [30].

This study analyzed the diagnostic value of sIL-2R, TNF-α and PCT in patients with sepsis. The results showed that the median level of sIL-2R, TNF-α and PCT in the infected group was 835.50 U/mL, 11.45 pg/mL and 0.73 ng/mL, respectively. The median level of sIL-2R, TNF-α and PCT in the sepsis group was 1879.00 U/mL, 31.20 pg/mL and 6.56 ng/mL, respectively. The levels of sIL-2R, TNF-α and PCT in sepsis group were significantly higher than those in infection group, and the differences were statistically significant ($P < 0.05$).

The level of sIL-2R in sepsis patients was positively correlated with WBC, CRP, SAA, IL-6 and APACHE Ⅱ, and it was also positively correlated with CRP, SAA and IL-6 in the infection group, indicating that the level of sIL-2R could better reflect the indicators related to inflammation. Similarly, studies have shown that interleukin is an important pro-inflammatory cytokine released by immune cells in vivo, which can regulate immune response and call immune cells to the site of infection, and interleukin presents inflammatory response after activation of the complement pathway [31]. The level of TNF-a was positively correlated with WBC, SAA and IL-6 in the sepsis group, and was positively correlated with IL-6 in the infection group, which also indicated that the level of TNF-α could better reflect the progression of inflammation, and the correlation between TNF-α level and sepsis group was better than that of the infection group. TNF-α plays a central role in systemic inflammatory response due to its ability to release other cytokines in the early stage of infectious disease and its direct influence in septic shock, and plasma levels of TNF-α are associated with sepsis induced death [32]. The level of PCT was positively correlated with IL-6 only in the sepsis group and CRP only in the infection group. The results showed that the levels of sIL-2R, TNF-α and PCT were correlated with other laboratory indicators of infection in the two groups of patients, but there were more correlated indicators of sIL-2R and TNF-α in sepsis patients than PCT, which may be related to the differences in sensitivity and specificity between the test items.

The ROC curves of each index and the combined test produced by GraphPad Prism software showed that the AUC values of sIL-2R, TNF-α, PCT and sIL-2R + TNF-α + PCT were 0.827, 0.781, 0.821, 0.846, respectively. All the above indicators are higher than the AUC values of WBC, CRP, SAA and IL-6, and the

diagnostic performance is relatively good, which is basically consistent with previous reports [33]. Then, the AUC of sIL-2R, TNF-α, PCT and the combination of sIL-2R + TNF-α + PCT were compared, and there was no statistical significance in the AUC of sIL-2R and TNF-α, sIL-2R and PCT, and TNF-α and PCT ($P > 0.05$). There was no significant difference in the AUC between the combined test and the sIL-2R and PCT tests ($P > 0.05$), and the AUC of the combined test was greater than that of TNF-α ($P < 0.05$), indicating that the two sIL-2R and PCT tests alone were not superior to the three combined tests in terms of diagnostic performance.

The risk of sIL-2R, TNF-α, and PCT levels in sepsis was assessed by binary Logistic regression analysis, with median cut-off points (two classifications) and quartile (P25, P50, P75) as cut-off points (four classifications), respectively. The results showed that the corrected sIL-2R, TNF-α and PCT high level group was not superior to low level group when the median cut point was used for the classification of the two groups ($P > 0.05$). When the four groups were classified using quantile as cut points, the OR risk values of the high level of TNF-α and PCT (Q4) and the low level of PCT (Q1) after correction were 7.991 and 21.76, respectively, the difference being statistically significant ($P < 0.05$). There was no significant difference between the other groups and the low level group (Q1) ($P > 0.05$). The results showed that when PCT ≥ 6.67 and TNF-α ≥ 39.4, PCT and TNF-α could be used as predictors of the risk of sepsis.

Conclusions

The detection of sIL-2R, TNF-α and PCT in patients with sepsis has a good value for the diagnosis for sepsis infection in patients with closed abdominal injury complicated with severe multiple abdominal injuries, while there is no significant difference in the diagnostic performance between sIL-2R and PCT alone and three combined tests. However, high concentrations of PCT and TNF-α can be used as predictors of the risk of septic infection. It is worth noting that due to the small sample size, further collection of more samples and prospective design studies are needed to better evaluate the value of each indicator in the diagnosis of sepsis.

Declarations

Ethical Approval and Consent to participate All specimens were enrolled after obtaining informed consent of the patients or their family and the written informed consent from the participants were obtained. The study was approved by the Ethics Committees of the 903rd Hospital of PLA (Approval nos. PLA-117-20160518).

Consent for publication The authors confirm that they have obtained written consent from each patient to publish the manuscript.

Availability of data and materials: All data relevant to the study are included in the article.

Competing interests: The authors have declared that no competing interests exists.

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Figures

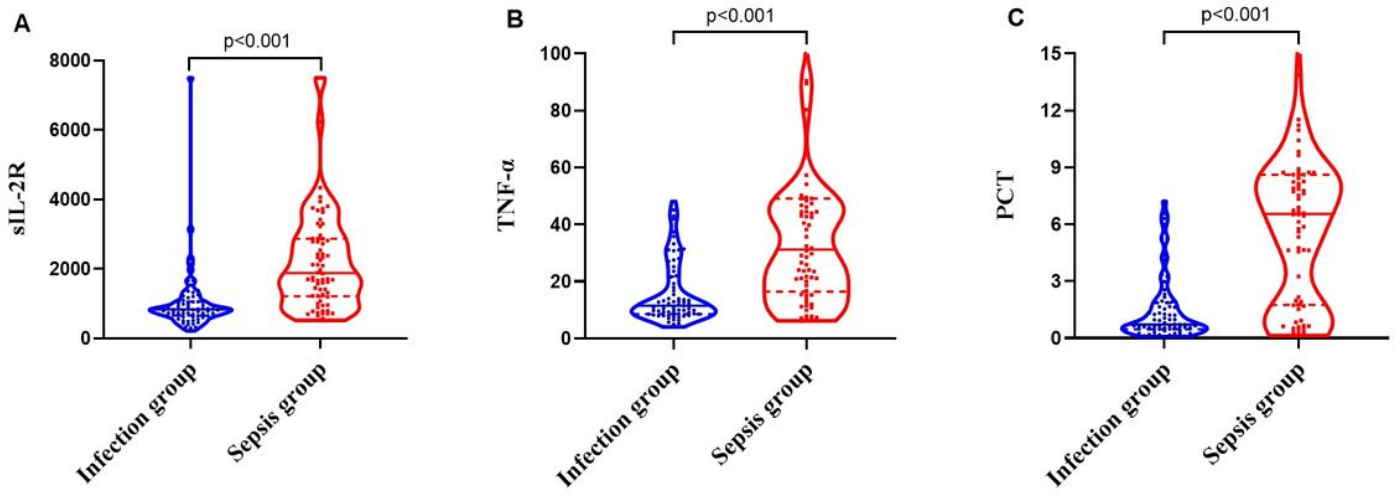

Figure 1

Differences in the expression levels of sIL-2R, TNF-a and PCT between infection group and sepsis group. A. Differences in the expression levels of sIL-2R between the infection group and sepsis group; B. Differences in the expression levels of TNF-a between the infection group and sepsis group; C. Differences in the expression levels of PCT between the infection group and sepsis group.

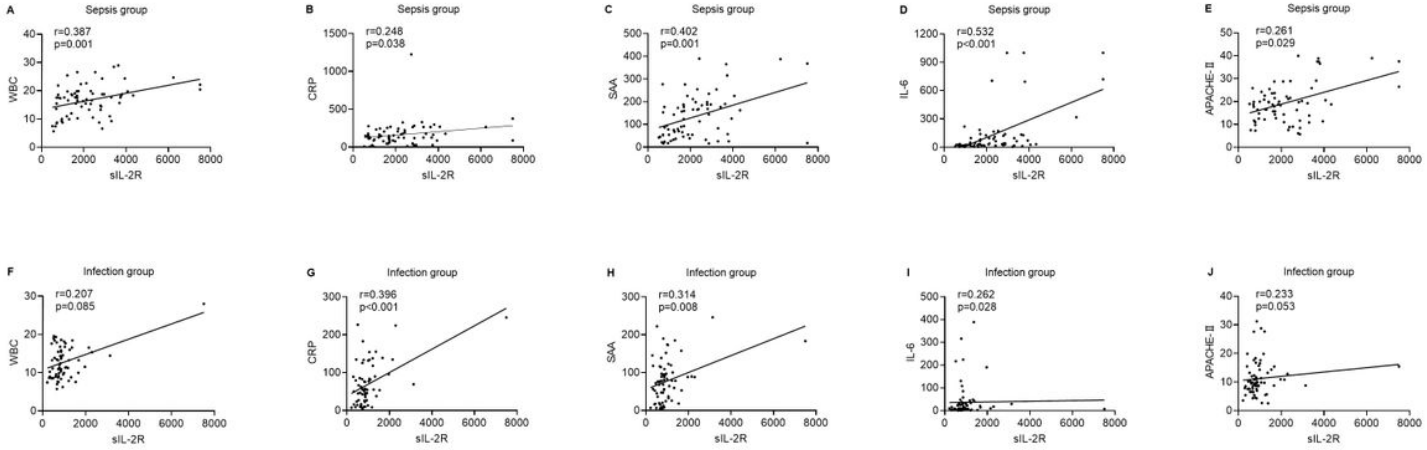

Figure 2

Correlation of sIL-2R with commonly used infection markers WBC, CRP, SAA, IL-6, APACHE II in patients in the infection group and sepsis group. A. Correlation of sIL-2R with WBC in patients in the sepsis group; B. Correlation of sIL-2R with CRP in patients in the sepsis group; C. Correlation of sIL-2R with SAA in patients in the sepsis group; D. Correlation of sIL-2R with IL-6 in patients in the sepsis group; E. Correlation of sIL-2R with APACHE Ⅱ in patients in the sepsis group; F. Correlation of sIL-2R with WBC in patients in the infection group; G. Correlation of sIL-2R with CRP in patients in the infection group; H. Correlation of sIL-

2R with SAA in patients in the infection group; I. Correlation of sIL-2R with IL-6 in patients in the infection group; J. Correlation of sIL-2R with APACHE Ⅱ in patients in the infection group.

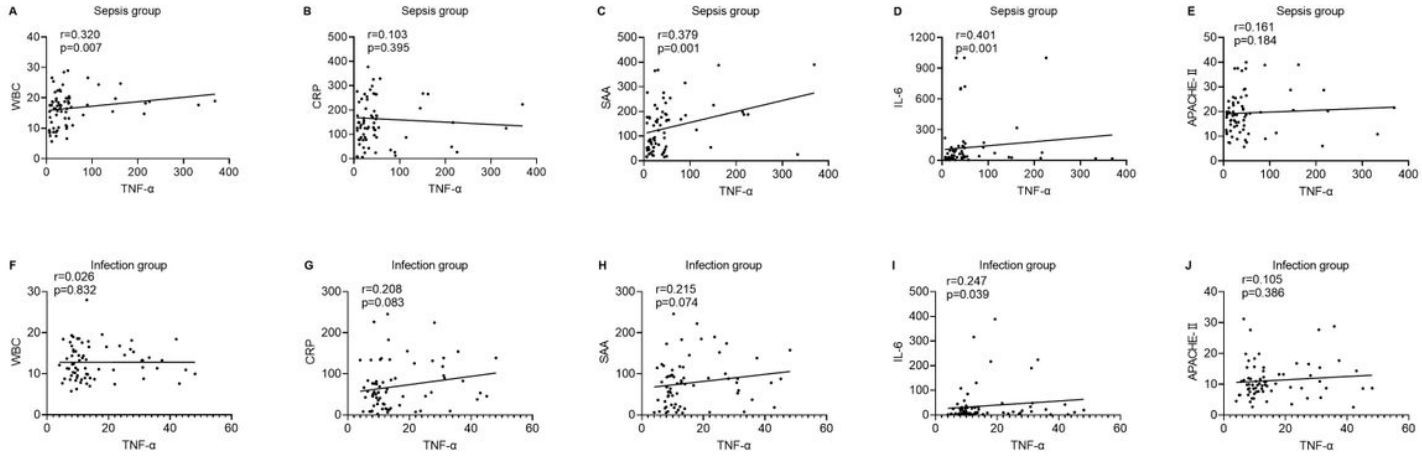

Figure 3

Correlation of TNF-α with commonly used infection markers WBC, CRP, SAA, IL-6, APACHE II in patients in the infection group and sepsis group. A. Correlation of TNF-α with WBC in patients in the sepsis group; B. Correlation of TNF-α with CRP in patients in the sepsis group; C. Correlation of TNF-α with SAA in patients in the sepsis group; D. Correlation of TNF-α with IL-6 in patients in the sepsis group; E. Correlation of TNF-α with APACHE Ⅱ in patients in the sepsis group; F. Correlation of TNF-α with WBC in patients in the infection group; G. Correlation of TNF-α with CRP in patients in the infection group; H. Correlation of TNF-α with SAA in patients in the infection group; I. Correlation of TNF-α with IL-6 in patients in the infection group; J. Correlation of TNF-α with APACHE Ⅱ in patients in the infection group.

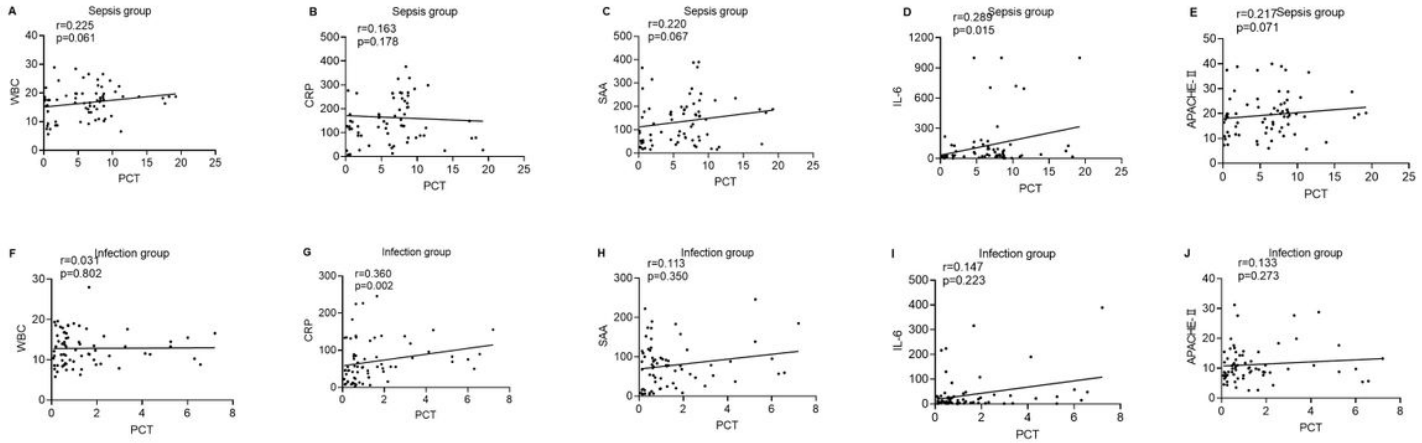

Figure 4

Correlation of PCT with commonly used infection markers WBC, CRP, SAA, IL-6, APACHE II in patients in the infection group and sepsis group. A. Correlation of PCT with WBC in patients in the sepsis group; B. Correlation of PCT with CRP in patients in the sepsis group; C. Correlation of PCT with SAA in patients in

the sepsis group; D. Correlation of PCT with IL-6 in patients in the sepsis group; E. Correlation of PCT with APACHE Ⅱ in patients in the sepsis group; F. Correlation of PCT with WBC in patients in the infection group; G. Correlation of PCT with CRP in patients in the infection group; H. Correlation of PCT with SAA in patients in the infection group; I. Correlation of PCT with IL-6 in patients in the infection group; J. Correlation of PCT with APACHE Ⅱ in patients in the infection group.

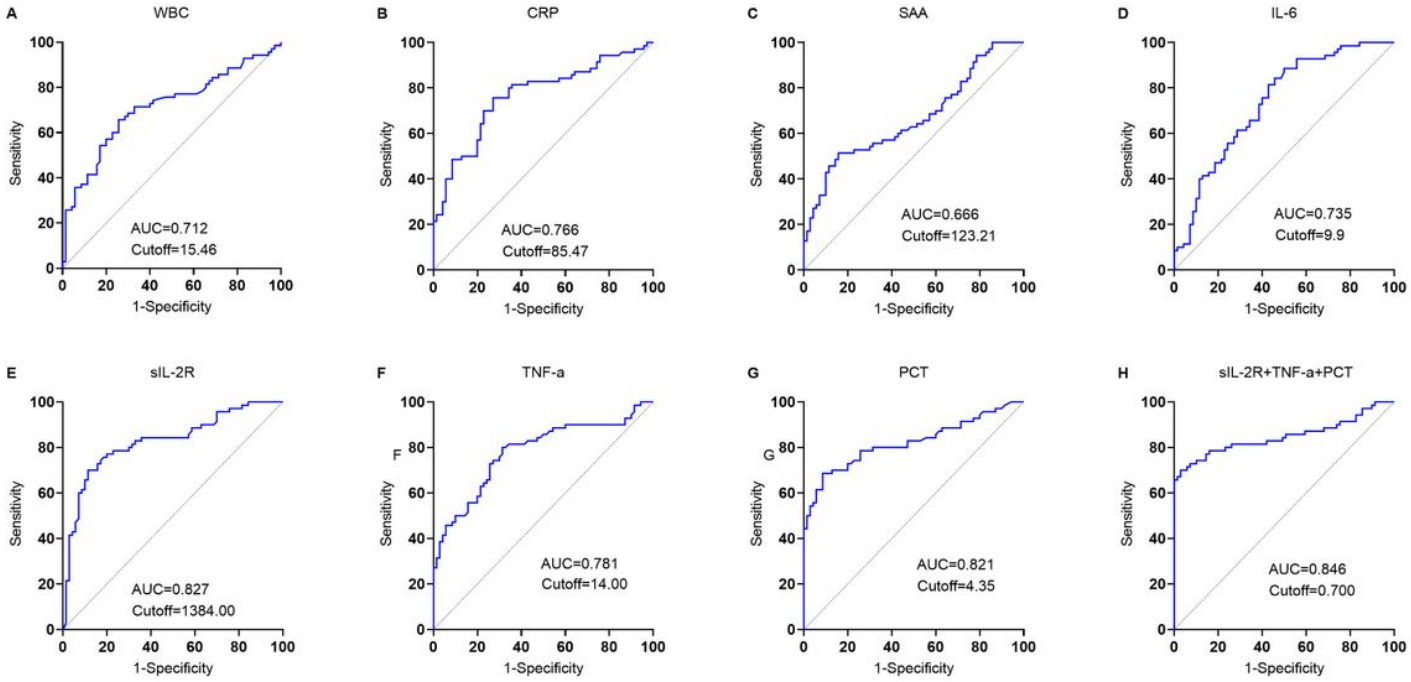

Figure 5

The diagnostic value of laboratory infection markers in patients in the sepsis group versus the infection group. A. The diagnostic value of WBC in patients in the sepsis group versus the infection group; B. The diagnostic value of CRP in patients in the sepsis group versus the infection group; C. The diagnostic value of SAA in patients in the sepsis group versus the infection group; D. The diagnostic value of IL-6 in patients in the sepsis group versus the infection group; E. The diagnostic value of sIL-2R in patients in the sepsis group versus the infection group; F. The diagnostic value of TNF-a in patients in the sepsis group versus the infection group; G. The diagnostic value of PCT in patients in the sepsis group versus the infection group; H. The diagnostic value of APACHE Ⅱ in patients in the sepsis group versus the infection group.

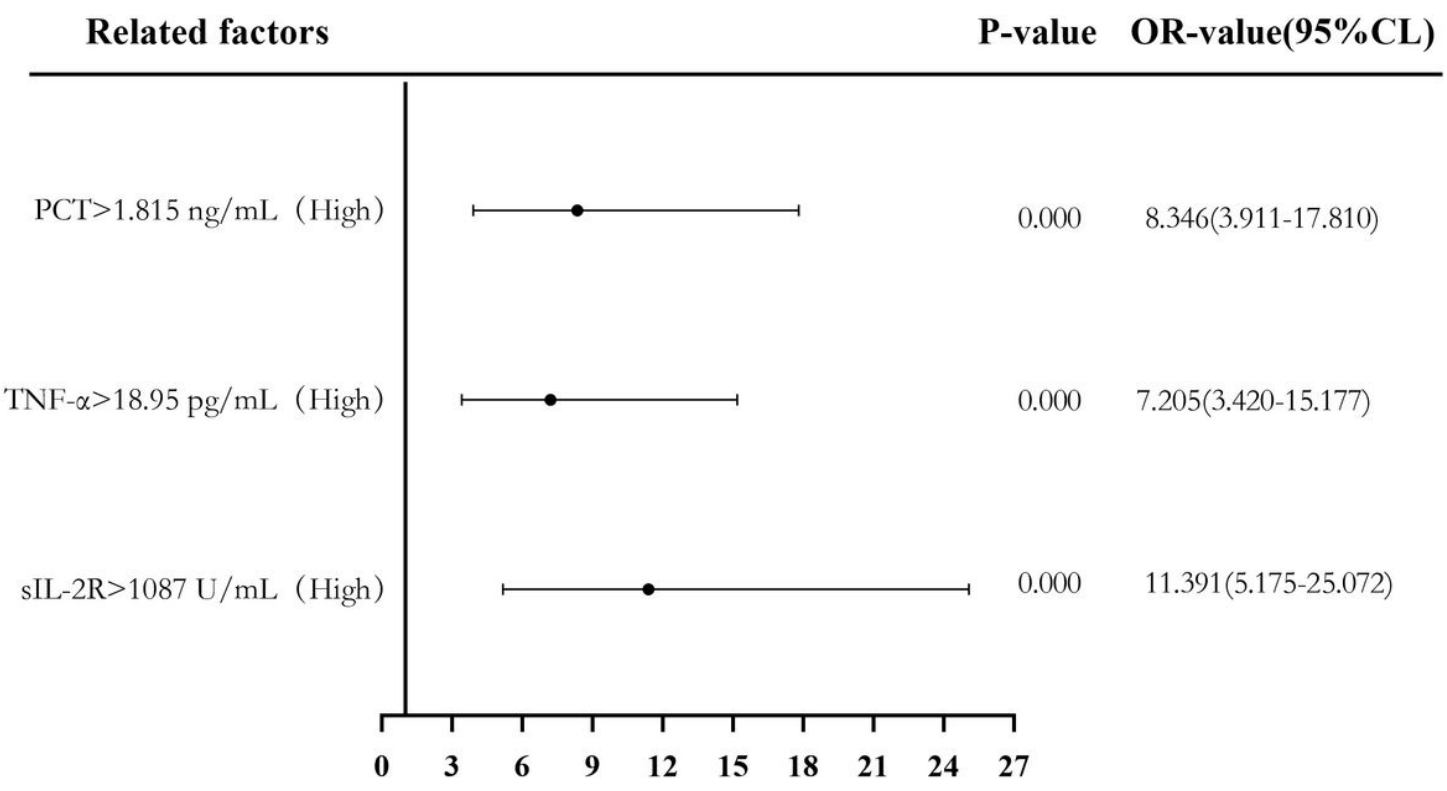

Figure 6

The forest plot of univariate logistic regression analysis of sIL-2R, TNF-a, PCT and infection in patients with sepsis.

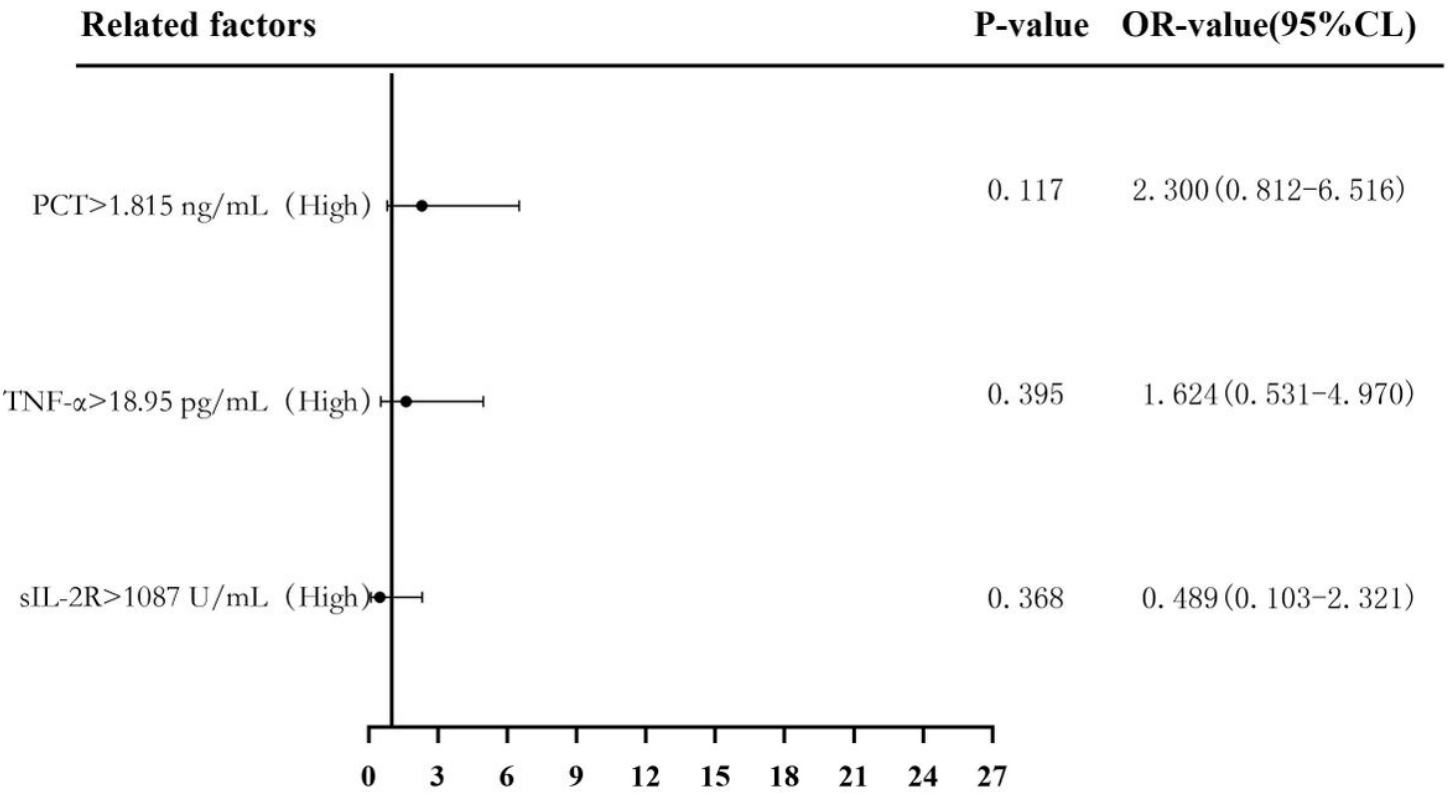

Figure 7

The forest plot of multifactorial logistic regression analysis of sIL-2R, TNF-a, PCT and infection in patients with sepsis Note: multifactorial correction included variables: sIL-2R, TNF-a, PCT, WBC, CRP, SAA, IL-6, APACHE II.

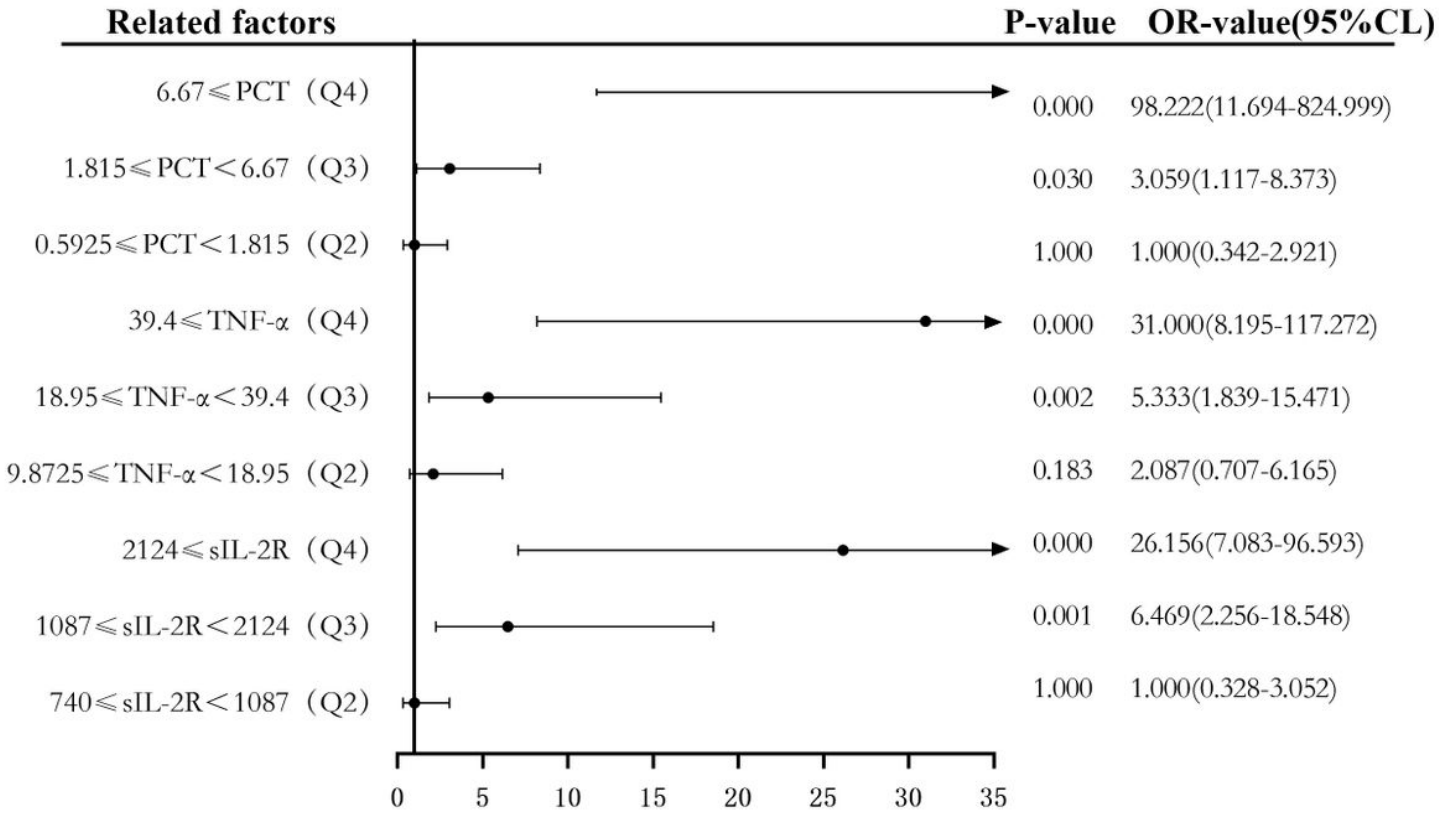

Figure 8

The forest plot of univariate logistic regression analysis of sIL-2R, TNF-a, PCT and infection in patients with sepsis.

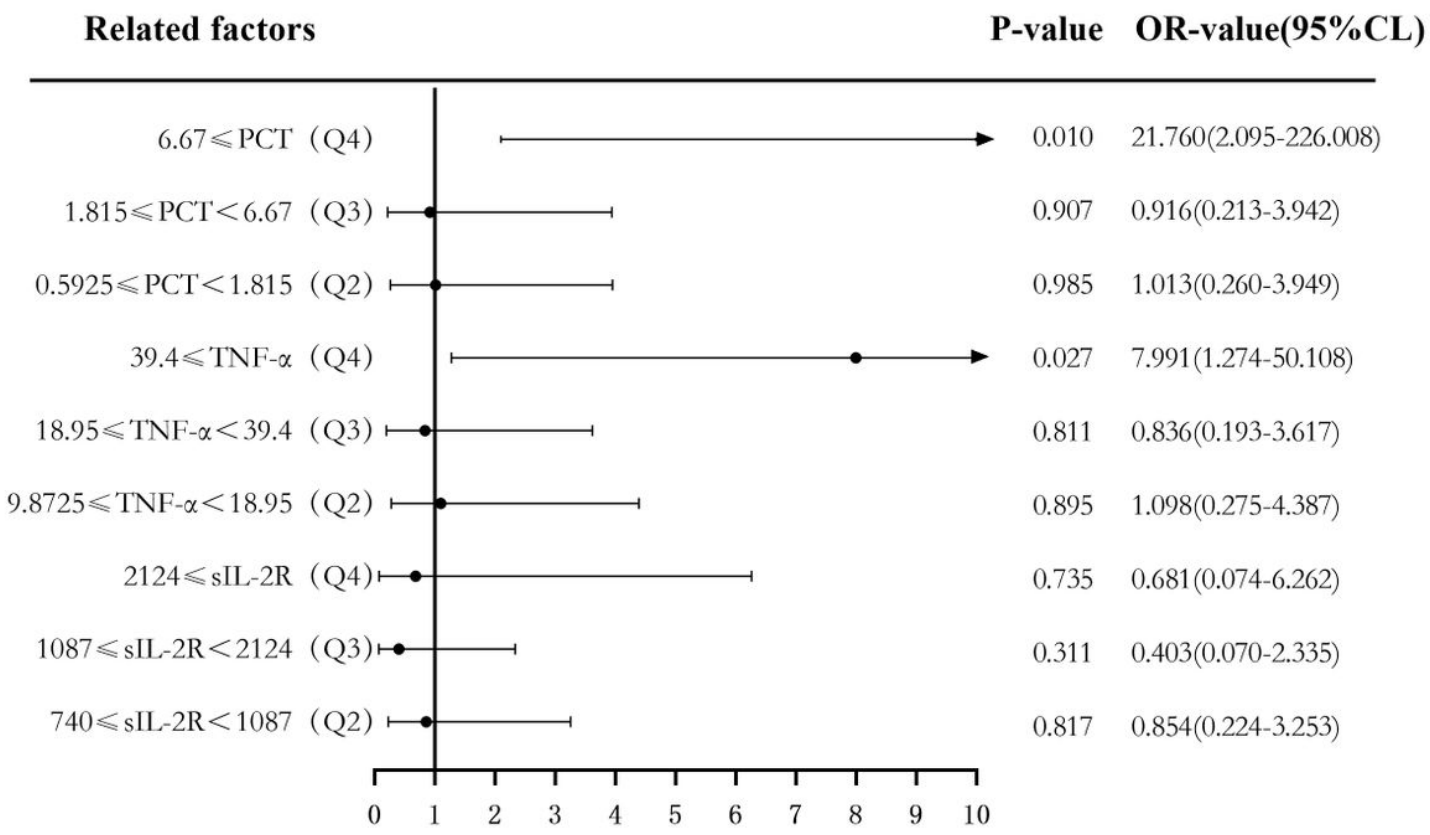

Figure 9

The forest plot of multi-factor logistic regression analysis of sIL-2R, TNF-a, PCT and infection in patients with sepsis Note: Multi-factor corrected inclusion variables include: sIL-2R, TNF-a, PCT, WBC, CRP, SAA, IL-6, APACHE II.