PERIPHERAL BLOOD RDW AND SERUM LEVELS OF SUPAR, BNP AND PCT IN PROGNOSTIC EVALUATION OF ICU PATIENTS WITH A BACTERIAL INFECTION IN THE BLOODSTREAM

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ABSTRACT

Objective: To evaluate prognostic indicators of ICU patients with acute bloodstream bacterial infections; these indicators are peripheral blood red blood cell distribution width (RDW), serum soluble urinary creatinase-type plasminogen activator receptors (suPAR), B-type natriuretic peptides (BNP), and C-reactive proteins (PCT).

Methods: Ninety patients with bloodstream bacterial infections treated in the hospital's ICU from October 2018 to October 2019 were allocated to the study group; the group was then divided into two groups according to each patient's prognosis: survival (n = 56) and death (n = 34). Simultaneously, 30 healthy participants who had undergone physical examination in the hospital's physical examination centre were allocated to the control group. Levels of SuPAR were detected using an enzyme-linked immunosorbent assay, CRP levels were detected using ultra-sensitive latex-enhanced immune turbidimetry, and PCT levels were detected using the Chemiluminescence method. Levels of RDW were detected and calculated using a fully automatic immunoanalyser. Multivariate logistic regression was used to analyse influencing factors in the prognoses of patients with bloodstream bacterial infections, and the ROC curve was used to analyse the prognostic value of RDW, suPAR, BNP, PCT for patients with bloodstream bacterial infections.

Results: The levels of serum RDW, suPAR, BNP and PCT in patients in the study group were significantly higher than those in the control group, and the differences were statistically significant (P<0.01). The levels of serum RDW, suPAR, BNP and PCT in the death group were significantly higher than those in the survival group, and the differences were statistically significant (P<0.01). The Multivariate Logistic regression analysis showed that sCD163, hs-CRP, WBC, PCT, and CPIS scores were independent risk factors affecting the prognosis of patients with bloodstream bacterial infections (P<0.05). For patients with bloodstream bacterial infections, the ROC curve analysis showed that the AUC of RDW for patients with bloodstream bacterial infection was 0.742 and the optimal cut-off was 15.66; sensitivity at this point was 73.25% and specificity was 71.48%. The AUC of suPAR was 0.893 and the optimal cut-off value was 13.48 ng/ml; sensitivity at this point was 83.54%, and specificity was 85.17%. The AUC of PCT was 0.656 and the optimal cut-off value was 43.17 ng/ml; sensitivity at this point was 64.11% and specificity was 71.16%. The AUC of BNP was 0.875 and the optimal cut-off value was 315.68 pg/ml; sensitivity at this point was 81.25% and specificity was 84.71%.

Conclusion: The levels of RDW, suPAR, BNP, and PCT in the serum of patients with bloodstream bacterial infection were significantly increased; this suggests these indicators have value for assessing the prognosis of patients, especially suPAR and BNP.

Keywords: RDW, suPAR, BNP, PCT, ICU, bloodstream bacterial infection, prognosis, evaluation, value.

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Introduction

Bloodstream infection (BSI), including sepsis and bacteraemia, is one of the most serious manifestations of infectious diseases and is caused by bacteria becoming bloodstream bacterial infections[1]. Bloodstream bacterial infections can demonstrate a range of symptoms, including sudden high fevers, chills, tachycardia, rashes, shortness of breath, hepatosplenomegaly, and altered consciousness. In severe cases, shock, disseminated intravascular coagulation, and multiple organ failure can occur, endangering patients' lives[2]. The incidence of BSIs has gradually increased with the development of trauma diagnosis and treatment technology and the widespread use of antibacterial drugs and hormones[3]. Bloodstream infections can prolong the length of a hospital stay, increase the cost of hospitalisation for

patients, and rapidly escalate a disease with a high mortality rate. Therefore, early diagnosis and treatment have become important measures for reducing patient mortality and improving patient prognoses[4]. At present, blood culture is the main method for testing patients with a BSI, but it takes a long time and the early false-negative rate is high[5].

Studies have found that distribution of red blood cells (RDW), soluble urinary creatine type plasminogen activator receptors (suPAR), B-type natriuretic peptides (BNP), and C-reactive protein (PCT) levels are abnormally expressed in the serum of patients with a BSI. This suggests these factors may play a role in diagnosing BSI and evaluating prognoses[6]. This trial was conducted to investigate the value of RDW, suPAR, BNP and PCT levels in the prognostic evaluation of patients with bacterial infection in the bloodstream in ICU.

Materials and methods

General information

Patients with a BSI treated in the study hospital from October 2018 to October 2019 were used as the study group. The primary criterion was bacterial infection confirmed by multiple blood culture tests, and the secondary criteria were PaO2 <32mmHg or respiratory frequency >20 times/min; temperature >38oC or <36oC; heartrate >90 bpm; white blood cell count in serum <4×109/L or >12×109/L; immature white blood cell count >10%.

All of the patients who met the primary criterion and two or more secondary criteria were diagnosed with a BSI.

Exclusion criteria:

• Were having severe cardiac, hepatic, and renal dysfunction;

• Having an autoimmune disease;

• Also having a malignant tumour;

• Refusing the test or poorly complying with requests.

There were 90 patients in the study group, comprising 48 males and 42 females; the average age was 45.11±9.18 years old; the average BMI value was 20.01±1.11 kg/m².

Healthy participants collected from the hospital's physical examination centre during the same period were used as the control group. There were 30 patients in the control group, comprising 17 males and 13 females; the average age was 45.05±9.15 years old; the average BMI value was 20.04±1.03 kg/m². According to the prognoses of the patients, the study

group was divided into a survival group (n = 56) and a death group (n = 34). The 56 patients in the survival group included 30 males and 26 females, the average age was 45.10±9.14 years old, and the average BMI was 20.07±1.12 kg/m².

The 34 patients in the death group included 18 males and 16 females, the average age was 45.11±10.01 years old, and the average BMI value was 20.15±1.05 kg/m². There were no significant differences in age, gender or BMI between the subjects in each group (P>0.05).

Observation indicators

A five ml sample of post-fasting venous blood was collected from all subjects in the morning, put in a centrifuge at 3000 r/min at low temperature, and then the serum was carefully separated and stored in the minus 80oC refrigerator to avoid repeated freeze-thaw. The enzyme-linked immunosorbent assay was used to detect the levels of suPAR in the serum of all subjects, the CRP level was detected using the high-sensitivity latex-enhanced immune turbidimetric method, the serum PCT level was detected using the electrochemiluminescence method, and the RDW level was detected and calculated using an automatic immunoassay.

Statistical methods

The data in this study were analysed using the SPSS 20.0 software package for statistical data analysis. All measurement data comparisons were expressed as ($\bar{x}$±s)., comparisons between groups were performed using a t-test, count data were expressed as percentages, and comparisons between groups were performed using a χ^2 test.

Grade data comparison was performed using Ridit test. Multivariate Logistic regression was used to analyse the influencing factors of the prognoses of patients with a BSI, and the ROC curve was used to analyse the prognostic value of RDW, suPAR, BNP and PCT for patients with a BSI. A P value of <0.05 was considered statistically significant.

Results

Comparison of serum RDW, suPAR, BNP and PCT levels between two groups

The levels of serum RDW, suPAR, BNP and PCT in the study group were significantly higher than the levels in the control group, as seen in Table 1. The differences were statistically significant (P<0.01).

Group	Case	RDW	suPAR (ng/ml)	PCT (ng/ml)	BNP (pg/ml)
The control group	90	13.15±0.85	4.26±3.15	22.15±18.12	98.26±35.16
The study group	30	15.26±1.56	12.56±3.62	48.56±23.15	325.26±186.59
t		7.054	11.215	5.688	6.606
P		<0.001	<0.001	<0.001	<0.001

Table 1: Comparison of serum RDW, suPAR, BNP, and PCT levels between two groups ($\bar{x}\pm s$).

Comparison of serum RDW, suPAR, BNP and PCT levels in patients with different prognoses of BSI

The levels of serum RDW, suPAR, BNP, and PCT in the death group were significantly higher than the levels in the survival group, as seen in Table 2. The differences were statistically significant ($P<0.01$).

Group	Case	RDW	suPAR (ng/ml)	PCT (ng/ml)	BNP (pg/ml)
The survival group	56	14.22±1.22	7.59±3.45	33.48±6.48	123.26±41.15
The death group	34	16.36±2.14	17.86±4.82	51.26±26.23	451.26±100.48
t		6.049	11.753	4.850	21.675
P		<0.001	<0.001	<0.001	<0.001

Table 2: Comparison of serum RDW, suPAR, BNP, and PCT levels in patients with different prognoses of BSI ($\bar{x}\pm s$).

Analysis of independent risk factors affecting the prognosis of patients with bloodstream bacterial infection

Multivariate Logistic regression analysis showed that sCD163, hs-CRP, WBC, PCT, and CPIS scores were independent risk factors affecting the prognosis of patients with a BSI, as seen in Table 3 ($P<0.05$).

Factor	OR	95%*CI*	*P*
RDW	1.041	1.014-1.110	0.015
suPAR	2.124	1.521-3.311	0.021
PCT	1.345	1.163-1.768	0.002
BNP	2.103	1.436-3.452	0.011

Table 3: Analysis of independent risk factors affecting the prognosis of patients with bloodstream bacterial infections.

Analysis of the prognostic value of RDW, suPAR, BNP, PCT in patients in ICU with bacterial infections in bloodstream

For patients with a BSI, the ROC curve analysis showed that the AUC of RDW for patients with a BSI was 0.742 and the optimal cut-off was 15.66; the sensitivity at this point was 73.25% and the specificity was 71.48%. The AUC for suPAR was 0.893 and the optimal cut-off value was 13.48 ng/ml; the sensitivity at this point was 83.54%, and the specificity was 85.17%.

The AUC for PCT was 0.656 and the optimal cut-off value was 43.17 ng/ml; the sensitivity at this point was 64.11% and the specificity was 71.16%. The AUC of BNP was 0.875 and the optimal cut-off value was 315.68 pg/ml; the sensitivity at this point was 81.25%, and the specificity was 84.71%. These findings are represented in Table 4.

Inspection index	AUC	95%CI	Optimal cut-off value	The sensitivity	The specificity
RDW	0.742	0.687-0.818	15.66	73.25%	71.48%
suPAR	0.893	0.843-0.948	13.48	83.54%	85.17%
PCT	0.656	0.615-0.686	43.17	64.11%	71.16%
BNP	0.875	0.815-0.933	315.68	81.25%	84.71%

Table 4: Evaluation of the prognostic value of various indicators for patients with bloodstream bacterial infection in ICU.

Discussion

Bloodstream bacterial infection is a clinically severe infectious disease which seriously damages people's health. Incidence of it has gradually increased in recent years due to the increase in resistance to bacteria because of the common use of antibacterial treatments[7]. The prognosis of a BSI is closely related to factors such as pathogenic bacteria, primary disease, whether timely and accurate treatment is given, and the basic conditions of the patient[8]. Therefore, early diagnosis and treatment, assessing the prognosis of patients and giving correct adjustments are significant for treating patients and improving the prognosis[9].

Red blood cell distribution width is a parameter that reflects the volume heterogeneity of red blood cells and is expressed by the coefficient representing variation in the volume of red blood cells.

A larger RDW value indicates more a uneven corporal red-blood-cell size and higher volume heterogeneity[10]. Studies have shown that RDW can be used as a predictive index to assess the risk and prognosis of infectious diseases such as sepsis and that it has greater clinical application value[11]. Another metric studied, SuPAR, is a surface signal re-

ceptor expressed only in leukocytes, and changes to its level can indicate the state of the body's immune system[12]. The measurement of BNP is important for diagnosing heart failure. Studies have found that abnormal expression of BNP in the serum of patients with a BSI may be related to those BSIs[13].

The final metric studied, PCT, is a serum marker used to evaluate infections and is of great significance in the diagnosis of bacterial infections; however, surgery and cardiogenic shock can also lead to an increase in PCT levels. Therefore, PCT should be considered with the specific conditions of patients[14]. In this study, levels of serum RDW, suPAR, BNP and PCT were significantly higher in the study group than in the control group. The differences were statistically significant ($P<0.01$). The levels of serum RDW, suPAR, BNP and PCT in the death group were significantly higher than those in the survival group. The differences were also statistically significant ($P<0.01$).

This suggests that changes in RDW, suPAR, BNP, and PCT levels are closely related to the occurrence, development, and prognosis of bacterial infections in the bloodstream. These findings are similar to those of Hou et al.[15].

To further explore the relationship between changes in RDW, suPAR, BNP, and PCT levels and the prognosis of patients with a BSI, a multivariate logistic regression analysis was performed in this experiment, using sCD163, hs-CRP, WBC, PCT, and CPIS scores as independent risk factors in the prognosis of patients with a BSI ($P<0.05$).

For patients with a BSI, the ROC curve analysis showed that the AUC of RDW for patients with bloodstream bacterial infection was 0.742 and the optimal cut-off was 15.66; sensitivity at this point was 73.25% and specificity was 71.48%. The AUC of suPAR was 0.893 and the optimal cut-off value was 13.48 ng/ml; sensitivity at this point was 83.54%, and specificity was 85.17%.

The AUC of PCT was 0.656 and the optimal cut-off value was 43.17 ng/ml; sensitivity at this point was 64.11% and specificity was 71.16%. The AUC of BNP was 0.875 and the optimal cut-off value was 315.68 pg/ml; sensitivity at this point was 81.25% and specificity was 84.71%. This suggests that the changes in RDW, suPAR, BNP and PCT levels are closely related to the prognosis of patients with a BSI. Therefore, levels of serum RDW, suPAR, BNP and PCT are valuable for assessing the prognosis of patients with a BSI. That is to say that this study has observed that the levels of RDW, suPAR,

BNP and PCT in the serum significantly increase in patients with a BSI. Levels of RDW, suPAR, BNP and PCT are, therefore, valuable for assessing the prognosis of patients, among which suPAR and BNP are of higher value.

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