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ORIGINAL

EVALUATING THE DIAGNOSTIC VALUE OF PROCALCITONIN AND C-REACTIVE PROTEIN IN EARLY SEPSIS DETECTION: IMPLICATIONS FOR IMMUNE FUNCTION, RECOVERY, AND PHYSICAL PERFORMANCE

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ABSTRACT

Background: Sepsis is a life-threatening condition characterized by dysregulated immune responses and systemic inflammation, leading to multiorgan dysfunction and impaired physical recovery. Early diagnosis and timely intervention are crucial for improving survival rates, optimizing rehabilitation, and maintaining functional capacity in critically ill patients. Procalcitonin (PCT) and C-reactive protein (CRP) are well-established inflammatory biomarkers, but their diagnostic accuracy and clinical utility in sepsis detection remain areas of active investigation. This study evaluates the application value of PCT and CRP levels in the early diagnosis of sepsis, with implications for critical care management, immune function, and post-sepsis rehabilitation in physically active individuals. **Methods:** A total of 302 critically ill patients admitted to the Intensive Care Unit (ICU) between February 1, 2020, and February 1, 2023, were included in this study. Patients were classified into three groups based on sepsis diagnostic criteria: sepsis group (n=102), septic shock group (n=87), and non-sepsis (control) group (n=113). Serum PCT levels were measured using enzyme-linked fluorescence analysis, while CRP concentrations were determined using fluorescence immunoassay quantification. The diagnostic performance of PCT and CRP was assessed through receiver operating characteristic (ROC) curve analysis, calculating

sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy. **Results:** No significant differences were observed among the three groups in age, gender, APACHE II scores, or ICU length of stay (P>0.05). However, ISS scores and hospital mortality rates were significantly higher in the sepsis and septic shock groups (P<0.05). PCT levels in the sepsis group (6.01±3.97 μg/L) were significantly higher than in the control group (1.67±0.92 μg/L, P<0.05), while CRP concentrations were also elevated in the sepsis group (34.90±15.70 mg/L) compared to controls (12.40±7.97 mg/L, P<0.05). The septic shock group exhibited the highest CRP levels (148.28±32.03 mg/L, P<0.05). The positive detection rates for PCT and CRP were significantly higher in septic shock (PCT: 93.1%, CRP: 90.8%) and sepsis patients (PCT: 80.4%, CRP: 79.4%) compared to controls (PCT: 29.2%, CRP: 25.7%) (X^2 =107.702, P<0.05). The combined PCT and CRP assay demonstrated superior diagnostic performance compared to either marker alone, with higher sensitivity (84.7%), specificity (87.6%), PPV (92.0%), NPV (77.3%), and overall accuracy (85.8%). ROC curve analysis showed an area under the curve (AUC) of 0.871-0.970 for the combined markers, significantly outperforming PCT alone (AUC = 0.850) and CRP alone (AUC = 0.814) (P<0.05). **Conclusion:** Serum PCT and CRP levels serve as reliable biomarkers for assessing sepsis severity, with higher concentrations correlating with more severe cases. The combined measurement of PCT and CRP significantly enhances early diagnostic accuracy, surpassing the performance of individual markers. These findings have critical implications for improving early sepsis detection, guiding timely interventions, and optimizing post-sepsis recovery protocols, particularly in patients requiring physical rehabilitation and functional restoration. Future research should explore the role of inflammatory biomarker monitoring in sports medicine and rehabilitation to mitigate the long-term impact of post-sepsis immune dysregulation and physical deconditioning.

KEYWORDS: Sepsis; Procalcitonin; C-Reactive Protein; Diagnosis

1. INTRODUCTION

Sepsis is a life-threatening systemic response to infection, characterized by immune dysregulation, widespread inflammation, and multi-organ dysfunction, which can severely impact physical function, recovery potential, and overall prognosis (Wang et al., 2020). As one of the leading causes of intensive care unit (ICU) admissions and mortality, early and accurate diagnosis of sepsis is critical for improving clinical outcomes, reducing long-term complications, and optimizing rehabilitation strategies. Despite advancements in critical care medicine, delayed diagnosis and inadequate early intervention continue to contribute to high mortality rates and prolonged physical impairment among sepsis survivors(Uusitalo-Seppälä et al., 2011). Given that systemic inflammation and immune dysfunction significantly affect metabolic balance, muscle function, and overall endurance, understanding the role of biomarkers

in early sepsis detection is essential for ensuring timely treatment and supporting physical recovery in critically ill patients, particularly those who require rehabilitation and functional mobility interventions. Among various inflammatory biomarkers, Procalcitonin (PCT) and C-reactive protein (CRP) have been widely studied for their diagnostic value in sepsis. PCT, a precursor of calcitonin, is produced in response to bacterial infections, with levels rising significantly in systemic inflammation, making it a valuable marker for distinguishing bacterial sepsis from other inflammatory conditions. CRP, an acute-phase reactant, is a widely used biomarker of inflammation and immune activation, reflecting tissue damage and systemic response to infection. While both markers have demonstrated potential in sepsis detection, their combined diagnostic efficacy in distinguishing early-stage sepsis from non-septic inflammatory conditions remains an area of active investigation. Furthermore, understanding how sepsis-related inflammation impacts metabolic and neuromuscular function is crucial for developing targeted rehabilitation strategies in survivors. In addition to the immediate risks associated with sepsis, patients often experience long-term physical complications, including muscle atrophy, reduced aerobic capacity, and prolonged fatigue, which can impair their ability to engage in physical activity and functional rehabilitation. Persistent systemic inflammation, mitochondrial dysfunction, and catabolic stress induced by sepsis contribute to exercise intolerance and delayed recovery, emphasizing the need for biomarker-guided interventions that facilitate immune stabilization and physical rehabilitation. Understanding how PCT and CRP levels correlate with sepsis severity and post-sepsis recovery outcomes can aid in developing integrated treatment plans that not only improve survival but also restore functional capacity and quality of life. (Zhou et al., 2021). For the early diagnosis of sepsis, markers with high clinical application value need to meet five conditions: Early diagnosis of inflammation and sepsis; Markers can be used in infection and non-infection, bacterial and viral infections, etc. Early identification of diseases; The content of biomarkers is positively correlated with the severity of the disease; The diagnostic indicators have high sensitivity and specificity; The prognosis of the disease can be evaluated according to the changes of the markers. The last several years, studies on sepsis have found that biochemical indicators such as white blood cell count, neutrophils, body temperature, and lactic acid are of great significance in the early diagnosis of sepsis, disease prediction, antibacterial drug application, and prognosis evaluation. It is believed that its sensitivity and specificity are not ideal enough, and it is difficult to reflect the development and changes of the disease only through the change of a certain index, especially in severe trauma patients (Tanak et al., 2019). PCT is a protein with 116 amino acids and a molecular weight of 14.5 kD. It was first proposed in 1984. It is a kind of calcitonin propeptide substance. In physiological state, it is a kind of calcitonin propeptide substance. If the body is infected by bacteria, due to the action of bacteria or bacterial endotoxin, the level of PCT in serum will increase, and it will increase after 2 hours of systemic

infection, and it will increase after 2 hours, and it can be accurately detected after 2 to 4 hours It has been found that the maximum value will appear after 6 hours, and it will remain in a relatively stable state after 8 to 24 hours. With the severity of the infection, the PCT value will become higher. When the PCT level is greater than 2 ug/L, it is considered that the PCT exceeds the normal value, and the higher the PCT level, the more severe the infection of the body. When the human body is infected by fungi or parasites, the level of serum PCT will be slightly higher than the normal value, but it will not increase as much as in bacterial infection, and when the human body is invaded by viruses, the level of serum PCT will usually not increase. Therefore, PCT plays a great role in the differential diagnosis of bacterial infection and viral infection, but it cannot distinguish sepsis caused by bacterial infection and non-bacterial infection well. CRP is a protein in the blood that is produced in the liver and is seen as a marker of an inflammatory response. In 1930, Tillet (Tillet) and Francis (Francis) first discovered in Tillet (Tillet) and Francis (CPS), that CRP is a substance formed by combining with C polysaccharide (CPS), that is, "C reaction Fragment" (Creative reactive fragmentation). CRP is a cyclic pentameric protein that reacts with C-glycosomes in a flocculent precipitation reaction when an acute infection occurs in the body. The pentameric protein has a strong ability to resist protease degradation and heat resistance (Fioretto et al., 2010). CRP is mainly synthesized by liver cells under the stimulation of inflammatory factors such as IL-6, IL-1 β , TNF- α , and some macrophages can also produce CRP.

Under normal circumstances, the synthesis rate of CRP is 1-10 mg/ Day, in the process of inflammatory response, CRP can be increased nearly 1000 times (Dimitrova-Karamfilova et al., 2019). It is speculated that its biological function may be to activate the complement and mononuclear phagocyte system by binding to the phospholipid components of apoptotic or necrotic cells or invading pathogens such as bacteria, fungi, and parasites, and then remove diseased substances in the body or pathogens. Many studies have shown that the serum concentration of normal people is <10 mg/L, but in patients with severe infection or sepsis, the CRP concentration will rise sharply 6 hours after the stimulation, and it will reach the maximum in about 48 hours. After elimination, its concentration will drop sharply and return to normal within a week, while viral infection will not increase significantly, which provides an extremely important basis for the identification of early infection types. For the diagnosis and treatment of sepsis, we mainly rely on the detection of clinical laboratory departments, usually using indicators such as blood bacterial culture, neutrophil count, white blood cell count, and secretion culture. However, when patients with sepsis and non-infectious diseases appear, it is still difficult to distinguish them using the above-mentioned detection methods. Even if positive cultures can be obtained through detection, the culture period will be relatively long, which makes medical workers There are certain limitations in the diagnosis of the disease and the formulation of a treatment plan, and there

is a lack of specificity (Knezevic Rangelov & Jankovic, 2021). Therefore, early and correct diagnosis and evaluation of patients with sepsis are very important. At present, PCT and CRP are clinically recognized biomarkers with high sensitivity, specificity and specificity. However, the last several years, domestic and foreign literatures have shown that PCT is comparable to WBC, CRP, and neutrophils in the early differential diagnosis of sepsis, the prediction of the severity of the disease, the trend of the disease development, and the evaluation of the prognosis of patients. Compared with indicators such as lactic acid and lactic acid, PCT has significant advantages. WBC, CRP and other indicators are not as accurate as PCT in the identification and diagnosis of sepsis, but PCT is higher than PCT in terms of sensitivity in comparing the diagnosis of sepsis (Huang et al., 2022).

2. Data and Methods

2.1 Research Object Data

In this paper, the data of inpatients were collected retrospectively through the electronic medical record system. We selected 302 critically ill patients admitted to the affiliated hospital from February 1, 2020 to February 1, 2023, and divided them into three groups: sepsis group, septic shock group and non-sepsis group. Effects on sepsis. There were 102 sepsis patients, aged 39 to 68 years old, 56 males and 46 females; 87 patients in the sepsis group, 42 to 75 years old, 47 males and 40 females; 113 patients in the comparison group, 50 males. There were 63 females, aged 40-74 years, 50 males and 63 females.

2.2 Survey Methods

2.2.1 Basis for Diagnosis and Grade of Disease

According to the sepsis diagnostic criteria and sepsis severity classification adopted by the World Conference on Definition of Sepsis in 2001. In which there are at least two indicators: body temperature higher than 38.0 ℃ or lower than 36.0 ℃; respiratory rate >20 beats/min or pulmonary artery CO2<32 mmHg; Heart rate over 90 beats per minute; Peripheral blood leukocytes>12×109/L, <4×109/L or immature cells greater than 10%. In the past, it was generally believed that "infection combined with SIRS" was too sensitive for the diagnosis of sepsis. Therefore, clinicians must have obvious or suspected infection in the diagnosis of sepsis, and on this basis, the following criteria are added. Physical condition: body temperature over 38.3 degrees Celsius, or lower than 36 degrees Celsius; respiratory rate over 30 times per minute; arrhythmia, arrhythmia, arrhythmia, arrhythmia; after 24 hours, the positive fluid balance value is 20 ml/kg above, or there is obvious edema; patients with hyperglycemia whose blood sugar is above 7.7 mmol/L do not have a history of diabetes. Inflammatory index: peripheral blood leukocytes>12 ×109/L, <4×109/L, immature cells>10%; PCT value is 2 standard deviations

higher than normal; C-reactive protein content is higher than normal 2 standard deviations per person. Hemodynamic indicators: low blood pressure; kg urine output is less than 0.5 ml/ml/hour); creatinine increased more than 44.2 micromoles/liter; coagulation abnormalities (INR>1.5, APTT>60 seconds); intestinal paralysis can make bowel sounds disappear; × 109 Thrombocytopenia below /L; hyperbilirubinemia occurs when total bilirubin levels exceed 70 mmol/L. Tissue perfusion indicators: high lactic acid (>3 mmol/L); capillary recharge lasts for a long time, or spots appear on the skin. It is worth noting that the diagnostic criteria for sepsis mentioned above does not emphasize that in addition to infection, it should also include 5 or more aspects of performance, and more is to be determined by the clinician according to the patient's The specific situation, combined with the abnormalities in laboratory tests, can be used to make a clinical diagnosis more consistent with sepsis. Sepsis is an acute circulatory dysfunction that is unexplained by other causes and manifests as hypotension, which is the most severe form of sepsis. The specific contents are: Insufficient blood perfusion or organ dysfunction (lactic acidosis, oliguria, acute loss of consciousness, etc.).

2.2.2 Entry Conditions

Judge based on the diagnostic criteria listed above;35 or 75 years old and above; Patients within 24 hours from the onset of illness to hospitalization.

2.2.3 Conditions not Applicable

Patients with severe liver and kidney damage; Patients with autoimmune diseases; Patients with severe heart failure; Patients with tumor history; ICU; The patient left during the operation. In this study, all subjects have obtained the consent of the doctor and the doctor, and under the guidance of the doctor, the subjects can leave the clinical observation at any time according to the doctor's request.

2.3 Data Collection

The electronic medical records and relevant data of all patients during the retrospective study period were collected, including the results of initial PCT, CRP, complete blood analysis, urine culture, blood culture and drug sensitivity identification.

2.4 Determination of Serum Albumin and C-Reactive Protein

PCT was determined by ELISA method, and C-reactive protein was determined by FISA method. PCT value greater than or equal to 0.5 μ g/L is positive; C-reactive protein (CRP) greater than or equal to 10.0 mg/L is positive;(Quan et al., 2023)

2.5 Statistical Analysis

Enter the obtained data into EXCEL, and after sorting and classifying, use SPSS18.0 to input the data and perform statistical processing. Variables are expressed as mean±standard deviation (x±s) and median (25%-75%); measurement data are subject to single-factor variance, Kruskal-Wallis H, and chi-square tests. Draw the ROC curve and compare the area under the curve.

3. Results

3.1 General Situation among the Three Case Groups

A total of 302 critically ill ICU patients and 102 septic patients were selected, including 56 males and 46 females, accounting for 54.9% of males and 46 females, accounting for 45.1% of females; among the 87 patients in the septic shock group, 47 were males., 40 were women, 54 were men, and 46 were women; there were 113 cases in the comparison group, including 50 men (44.2%) and 63 women (55.8%); see Table 1.

Table 1: Basic Data of Subjects

	COMPARISON GROUP (113 CASES)	SEPSIS GROUP (102 CASES)	SEPTIC SHOCK GROUP (87 CASES)	F/X2	P VALUE
AGE	55(40-74)	53(39-68)	60(42-75)	1389.6	>0.05
GENDER (MALE/ FEMALE)	50/63	56/46	47/40	0.658	>0.05
APACHE SCORE	12(8-22)	14(11-25)	21(14-32)	915.3	>0.05
ISS SCORE	22(14-31)	34(20-45)	45(25-68)	761.8	<0.05
GCS SCORE	12(8-15)	11(7-15)	8(4-12)	891.2	>0.05
BODY TEMPERATURE (℃)	37.0(36.1-37.8)	37.6(36.7-38.7)	38.2(37.4-39.5)	142.6	>0.05
ICU LENGTH OF STAY (DAYS)	6(4-12)	8(4-14)	12(5-20)	629.5	>0.05
HOSPITAL MORTALITY [N (%)]	14(12.4%)	17(16.7%)	29(33.3%)	5.681	<0.05

3.2 Comparison of PCT and CRP Detection Among Three Groups

The PCT value of the sepsis group was 6.01±3.97 ug/L, that of the septic shock group was 14.02±9.60 ug/L, and that of the comparison group was 1.67±0.92 ug/L. Results: The PCT level in the septic shock group was

higher than that in the comparison group (P < 0.05). Serum C-reactive protein (C-reactive protein) was 34.90±15.70 mg/L in the sepsis group, 14.29±2.4 mg/L in the septic shock group and 12.40±7.97 mg/L in the normal comparison group, respectively.

Table 2: PCT Examination Levels Among the 3 Groups (Mean ± Standard Deviation)

GROUP	NUMBER OF CASES	PCT (UG/L)	T VALUE	P VALUE
COMPARISON GROUP	113	1.67±0.92		
SEPSIS GROUP	102	6.01±3.97	41.41[a]	<0.05
SEPTIC SHOCK GROUP	87	14.02±9.60	51.05[b]	<0.05
DIFFERENCE ANALYSIS		F=113.58; P<0.05		

Note: *a Represents Comparison with the Comparison Group; B Represents Comparison with the Sepsis Group.*

Table 3: Comparison of serum CRP levels (mean±standard deviation) of patients in the three groups

GROUP	NUMBER OF CASES	CRP (MG/L)	T VALUE	P VALUE
COMPARISON GROUP	113	12.40±7.97		
SEPSIS GROUP	102	34.90±15.70	31.74[a]	<0.05
SEPTIC SHOCK GROUP	87	148.28±32.03	87.18[b]	<0.05
DIFFERENCE ANALYSIS		F=66.41; P<0.05		

Note: *A Represents Comparison with the Comparison Group; B Represents Comparison with the Sepsis Group.*

3.3 Test Results of PCT and C-Reactive Protein Detection in Three Groups of Patients

Most patients in the septic shock group and sepsis group had PCT levels greater than or equal to 0.5 ug/L. The PCT positive rate in the septic shock group was 93.1%. Most of the CRP levels in the septic shock group and sepsis group were greater than 10.0 mg/L. The CRP levels in the 3 groups There is a significant difference (X2=107.702); in Table 5, P<0.05).

Table 4: Comparison of Positive Rates of PCT among the Three Groups

GROUP	NUMBER OF CASES	PCT(UGL)		POSITIVE RATE (%)	χ^2 VALUE	P VALUE
		<0.5	≥0.5			
COMPARISON GROUP	113	80	33	29.2		
SEPSIS GROUP	102	20	82	80.4	56.462[a]	<0.05
SEPTIC SHOCK GROUP	87	6	81	93.1	6.393[b]	<0.05
DIFFERENCE ANALYSIS			χ^2=104.334； P<0.05			

Note: *A Represents Comparison with the Comparison Group; B Represents Comparison with the Sepsis Group.*

Table 5: Comparison of CRP Positive Rates Among Three Groups of Patients

GROUP	NUMBER OF CASES	CRP(MG/L)		POSITIVE RATE (%)	χ^2 VALUE	P VALUE
		<10.0	≥10.0			
COMPARISON GROUP	113	84	29	25.7		
SEPSIS GROUP	102	21	81	79.4	61.980[a]	<0.05
SEPTIC SHOCK GROUP	87	8	79	90.8	4.691[b]	<0.05
DIFFERENCE ANALYSIS		x^2=107.701； P<0.05				

Note: *A Represents Comparison with the Comparison Group; B Represents Comparison with the Sepsis Group.*

3.4 Use ROC Curve Method to Analyze PCT and CRP in Blood

Using SPSS18.0 statistical software for analysis, it was found that the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy (84.7%, 87.6%, 92.0%, 77.3%, 85.8%) of the combined detection of PCT and CRP were all significant. It is significantly higher than PCT alone (75.7%, 77.0%, 84.7%, 65.4%, 76.2%), and also higher than CRP alone (77.8%, 74.3%, 83.5%, 66.7%, 76.5%). There are significant differences. (P<0.05). The area under the ROC curve for the joint determination of PCT and CRP was 0.922, and the 95% CI was 0.872 and 0.971.

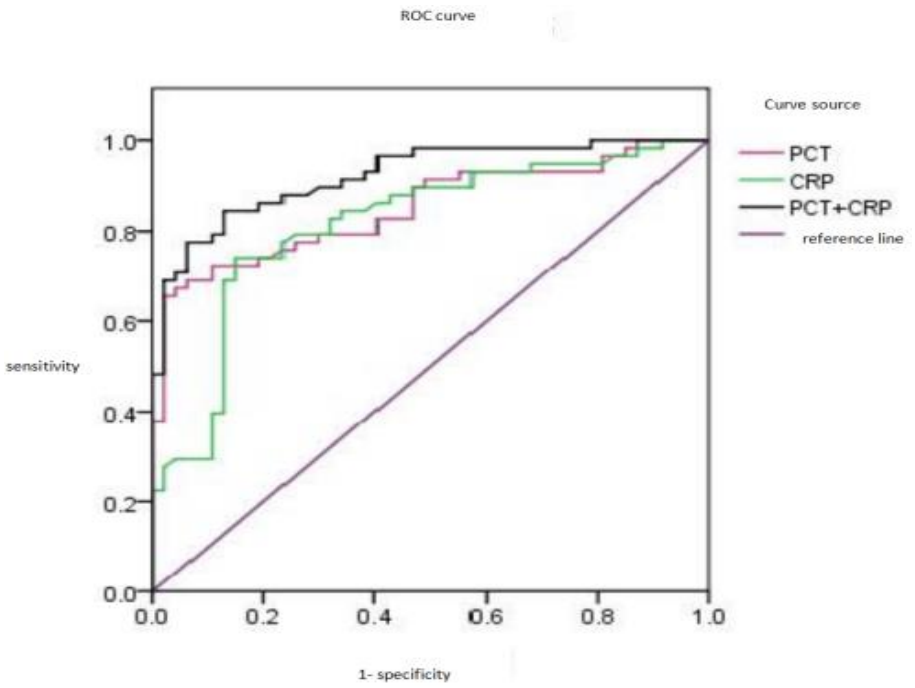

Figure 1: ROC Curve of PCT and CRP

Table 6: ROC Curve Analysis of PCT and CRP Detection

DETECTION INDICATOR	SENSITIVITY (%)	SPECIFICITY (%)	POSITIVE PREDICTIVE VALUE (%)	NEGATIVE PREDICTIVE VALUE (%)	ACCURACY (%)	AREA UNDER CURVE	95% CONFIDENCE INTERVAL	P VALUE
PCT	75.7(143/189)	77.0 (87/113)	84.7 (143/169)	654 (87/133)	76.2 (230/302)	0.85	0.776 , 0.922	<0.05
CRP	77.8 (147/189)	74.3(84/113)	83.5(147/176)	66.7(84/126)	76.5 (231/302)	0.814	0.731 , 0.897	<0.05
PCT+CRP	84.7 （ 160/189)	87.6 (99/113)	92.0 (160/174)	77.3 (99/128)	85.8 (259/302)	0.922	0.871 , 0.970	<0.05

4. Discussion

Sepsis is a rare systemic inflammatory response syndrome that has become a serious clinical complication that may be life-threatening. The last several years, although great progress has been made in the field of critical care, especially the treatment of septic shock, there are still more than 1.8 million sepsis patients worldwide, and they are still growing at a rate of 1.5% to 8.0%. with. So far, clinical medical staff's attention to sepsis has mainly focused on the early identification of sepsis, the timing of application of antibacterial drugs, the severity of the disease and treatment effect, and the prognosis of the patient (Zeng et al., 2022). In the traditional sense, the diagnosis of sepsis mainly relies on blood culture of the body. This leads to some flaws in the diagnosis. Therefore, finding biomarkers with high sensitivity and specificity for disease diagnosis and severity judgment in patients with sepsis has become a hot issue of concern to clinical medical workers. The last several years, with the development of biomarkers, a large number of biomarkers have been used in basic and clinical research.

Among the many sepsis markers, including PCT, CRP, lactate, WBC count, neutrophils, body temperature and other indicators, PCT and CRP are widely used (Güleç et al., 2022). Studies have shown that simply measuring PCT and CRP is of great significance in diagnosing sepsis and judging the severity of the disease. However, there are few reports on whether combining these two methods can improve the sensitivity and specificity of diagnosis.

Therefore, we intend to use serum PCT and CRP assays to evaluate their application value in the early diagnosis and condition evaluation of sepsis.

4.1 Correlation between Plasma PCT level and Disease Severity in Patients with Sepsis

PCT is a polypeptide that is synthesized and secreted by thyroid C cells in the body. This polypeptide is rare. It is composed of a variety of amino acids. Under normal circumstances, it can be processed by specific proteases. degradation. When bacteria infect the human body, a large amount of PCT will be released, which is thousands of times higher than the normal value. Therefore, when infection is suspected, the patient's serum PCT level can be tested to diagnose the patient or predict the possibility of the disease (Shang et al., 2022).The last several years, studies have found that in patients with sepsis, the measurement of PCT concentration can better diagnose them and judge the severity of their condition, and research in this area is gradually becoming a key issue in the field of critical care medicine. An important research direction. The detection of PCT was listed as an important index for the diagnosis of sepsis by the International Sepsis Society in 2001. Since PCT was considered a biomarker for sepsis diagnosis, many studies have shown that in the early stages of sepsis, PCT levels will rise rapidly, and will rise as the condition worsens, and will increase as the condition improves. It is very helpful for early diagnosis and judgment of sepsis condition changes, as well as the prognosis of patients (Golovnya et al., 2022).

Similarly, among many scholars who have tested and analyzed multiple biomarkers of sepsis, Suarez et al. found that PCT not only has a high predictive value for patient prognosis, but is also a good indicator of the severity of patient infection. mark. Our previous study found that the PCT concentration in the sepsis group, sepsis group and normal comparison group was 6.01±3.97 ug/L respectively, while the PCT concentration in the sepsis group was 14.02±9.60 ug/L. There was a significant difference between the two. Difference ($P<0.05$), PCT concentration is closely related to the severity of sepsis inflammatory response, Yu Haitao et al. have also published an article (Rao et al., 2022), but PCT concentration is closely related to the severity of sepsis inflammatory response. Research by Li Hongxiang and others has shown that PCT has a certain relationship with hypotension in patients with sepsis, and as blood pressure decreases, PCT values will become higher. In addition, there is a significant correlation between PCT and heart rate, oxygenation index, creatinine, platelet count and other indicators in patients with sepsis, which indirectly reflects the organ damage status of patients with sepsis. It can be seen that PCT is a good indicator to reflect the severity of the disease, and it can also help clinicians to effectively treat such patients.

4.2 Correlation between Serum C-Reactive Protein Level and Disease Severity in Patients with Sepsis

CRP is a non-glycosylated subunit composed of 5 subunits. It is synthesized and secreted in the liver and can be induced to express. Its mechanism of action may be through activating complement and specifically binding to lymphocytes, thereby inhibiting lymphocytes. Cell function, so as to achieve the purpose of suppressing the immune response, at the same time, it can also enhance the activity of macrophages, thereby enhancing their phagocytosis of foreign bacteria. CRP not only supports the inflammatory response, but also promotes it, and appears to play some protective role in the inflammatory response as well. During the period of acute inflammatory response, the level of CRP increases significantly, and some studies have shown that the synthesis of CRP is closely related to the local inflammatory response. Therefore, CRP has always been regarded as a marker of inflammatory response and indicates inflammatory response or infectious diseases. The emergence of. However, CRP will not only increase in the inflammatory state, but also significantly increase in pathological states such as tumors and connective tissue diseases, and will maintain a low level in the early stage of some severe bacterial infections, thus limiting the early stage of sepsis. diagnostic sensitivity. CRP is one of the diagnostic indicators of sepsis and plays a very important role in judging the severity of sepsis. Foreign scholars have confirmed that in the ICU, patients with high CRP have a higher incidence of organ failure and higher risk of death, and elevated CRP is associated with the severity of organ dysfunction in patients with sepsis. CRP reflects the severity of body injury to some extent, and related studies have also confirmed that CRP levels increase sequentially in the normal group, sepsis and septic shock. However, some studies have shown that the detection of CRP level is of little significance for the diagnosis and condition evaluation of sepsis.

4.3 The Early Diagnostic Value of Serum PCT and CRP Levels for Sepsis

Studies have found that there are differences in the sensitivity and specificity of individual biomarkers, and the roles played by different biomarkers in the pathogenesis of sepsis are not consistent. The application value of evaluation and other fields may be relatively low, and the joint detection of multiple biomarkers will be more conducive to the early diagnosis and condition assessment of sepsis than a single biomarker. Patients can use the dynamic monitoring of these biomarkers to guide the type and cycle of antibiotics, so as to avoid the abuse of antibiotics. Serum PCT is a glycoprotein that can identify the human body's fever response, and it is also a biomarker molecule of inflammatory response recognized by the International Medical Association. The application of PCT in sepsis, compared with CRP, white blood cell count, lactic acid and other indicators, PCT has higher accuracy, but compared with CRP, white blood cell counts and other indicators, the expression of PCT in

sepsis is higher Therefore, PCT is more specific for the diagnosis of sepsis. PCT is a commonly used sepsis diagnostic marker, but its diagnostic accuracy for sepsis is not yet clear (Woo et al., 2021). Although studies have shown that the diagnostic value of PCT for sepsis is higher than other biomarkers, combining PCT with other clinical data can significantly improve the detection rate of sepsis. CRP is an acute response protein produced when the body is inflamed, infected or injured. It is a relatively complete biomarker of infection and inflammation. Coupled with its rapid detection, CRP is gradually considered to be an infectious agent. Indicators [58]. CRP was identified as a diagnostic marker for sepsis by the European and American Society of Critical Care Medicine as early as 2001, and was also identified as a reference marker for sepsis in the 2013 "Rescue Sepsis Guidelines". However, clinically, CRP will not only increase significantly during bacterial infection, but also will increase significantly under stress conditions such as viral infection, surgery, trauma, etc. Therefore, the diagnosis of bacterial infection is still unclear. There is no definitive method. However, in the early screening of sepsis, it showed high sensitivity. Therefore, CRP levels are also monitored in patients after surgery. It is higher than before surgery but will soon return to normal unless the patient has an infection after surgery. There has been no consistent understanding of the value of CRP in how to distinguish infectious from non-infectious diseases, as well as related testing methods and standards for quantification of indicators, especially the determination of optimal detection thresholds. Although there are a variety of biomarkers for the diagnosis of sepsis, none of the single markers has a high diagnostic value for sepsis. Qiu Haibo, Yang Yi and others believe that the combined detection of PCT, sTREM-1 and multinucleated lymphocyte CD64 indicators has higher sensitivity and specificity for sepsis, but its specific mechanism is still unclear. However, previous studies have shown that the combination of CRP and IL-6 is not effective in predicting sepsis. Therefore, we intend to use serum PCT, CRP determination to evaluate the early diagnostic value of sepsis. Tables 4 and 5 show that in the septic shock group, sepsis group, and normal comparison group, the detection rate of PCT was 93.1%, the detection rate of PCT was 80.4%, and the detection rate of PCT was 29.2%. There were significant differences among the three groups (X2=104.335); results: (1) P<0.05), results: the detection rates of serum CRP concentration >10.0 mg/L in the three groups were 90.8%, 79.4%, and 25.7%, all There is significance (X2=107.702); P<0.05). From the above results, it can be seen that in patients with septic shock group and sepsis group, PCT and CRP increased significantly, and in sepsis group, PCT and CRP increased significantly. It was more pronounced in patients in the shock group, which is consistent with the findings of Akdag et al. (Ali et al., 2021). The ROC curve in Figure 1 shows that the sensitivity and specificity of combined PCT and CRP determination for sepsis, the positive and negative predictive values and accuracy (84.7%, 87.6%, 92.0%, 77.3%, 85.8%) are significantly high. Compared with simple PCT determination (75.7%, 77.0%, 84.7%, 65.4%,

76.2%), it was also significantly higher than that of simple CRP determination (77.8%, 74.3%, 83.5%, 66.7%, 76.5%) (P<0.05). The area under the ROC curve for the joint determination of PCT and CRP was 0.922, and the 95% CI was 0.872, 0.971; the area under the ROC curve for the PCT-level test was 0.850, and the 95% CI was (0.777, 0.923); the CRP concentration measurement results showed that the ROC curve the area under the curve was 0.814, and the area under the (0.730, 0.898) curve was 95% CI. According to the above results, the comparison between CRP and PCT showed that the sensitivity of CRP in patients with sepsis was higher than that of PCT, but the specificity was lower than that of PCT. High sensitivity means that the rate of CRP increase in sepsis patients is relatively high, and poor specificity means that the rate of CRP increase in sepsis patients is relatively low. In addition, various non-infectious factors such as trauma, surgery, and pancreatitis can cause the increase of CRP levels. Therefore, the diagnostic specificity of CRP in these special precursors will be lower. Since PCT has high specificity in diagnosing sepsis, the combined detection of PCT and CRP can improve the diagnostic accuracy of sepsis. That is, the high sensitivity of CRP can make up for the lack of PCT sensitivity. Combining the two serum markers can effectively address the diagnostic deficiencies of individual methods. Research has found that the combined detection of PCT and CRP is higher in sensitivity, specificity, area under the curve, etc. than PCT or CRP detection alone, which shows that the combined detection of PCT and CRP can improve the accuracy of early diagnosis of sepsis., and has great value in the diagnosis of infection status and disease severity, which is relatively close to the conclusion obtained by Lin Qing et al. Currently, although many experts believe that CRP and PCT can be used for the diagnosis of sepsis and have been widely used clinically, the specificity and sensitivity of these two methods are still not high enough, and clinicians still need to determine the diagnosis based on the patient's condition. Comprehensive judgment of relevant symptoms will cause a large number of sepsis patients to be misdiagnosed or delay important treatment time, and will also lead to the abuse of antimicrobial drugs. The combined detection of PCT and CRP has good application prospects in early diagnosis of sepsis and evaluation of disease severity. Its sensitivity and specificity are higher than those of PCT and CRP alone, and the diagnostic accuracy of sepsis has also been significantly improved., can be used as an effective diagnostic marker for sepsis. The last several years, with the deepening of research, some specific biomarkers, such as CD64, CD11b, CD35, sTREM-1, etc., are gradually considered to be indicators that can be combined with PCT, CRP, etc., and are closely related to PCT, CRP, etc. Together, they constitute the diagnostic score of sepsis, which points out the direction for future research.

5. Limitations of this Experiment

Due to the limitations of experimental time and equipment, the number of selected subjects is relatively small, and some subjects do not meet the

experimental conditions due to lack of medical record data or automatic discharge, and therefore cannot be included in the scope of the experiment, so they may be There are some deviations that need to be improved in subsequent experiments. Since the institute is an affiliated hospital, the selected samples are all hospital ICU patients, and most of them are people from surrounding areas, which cannot fully reflect the overall status of sepsis patients in my country. In the future, the cooperative units and research objects can be appropriately expanded. On this basis, multi-center clinical studies can be conducted on ICU patients from many domestic hospitals at the same level. Similar patients can also be included, thus expanding the number of samples., to reduce the degree of regionalization of patients and make the results more representative. Our preliminary research found that the PCT and CRP levels of ICU patients do not accurately reflect the dynamic changes of the patients' PCT and CRP levels. Therefore, we hope to understand the patient's diagnosis and disease by analyzing the dynamic changes of PCT and CRP levels. severity to better guide patient treatment

6. Conclusion

Sepsis and septic shock are two processes in which pathophysiological changes and disease severity gradually aggravate in patients with sepsis. In the early stage, active and accurate treatment is of great significance for the prevention and treatment of the disease and its complications. The early diagnosis of sepsis and its differentiation from non-bacterial infections have always been a difficult problem for clinicians. Although there are a variety of measurable biochemical markers, most of them have a certain auxiliary role in the diagnosis of patients and can According to the patient's condition, we can judge the patient's condition and severity, determine the patient's treatment timing, and reduce the incidence of complications. This article discusses the accuracy of PCT and CRP in the early diagnosis and severity of sepsis, and draws the following conclusions:1. PCT and CRP levels are important indicators for judging the severity of sepsis patients. The higher the PCT and CRP levels, the stronger the severity of sepsis.2. The sensitivity and specificity of joint measurement of serum PCT and CRP are significantly higher than those of simple measurement of PCT and CRP, indicating that joint measurement of serum PCT and CRP levels can improve the accuracy of early diagnosis of sepsis.

REFERENCES

Ali, W. A., Bazan, N. S., Elberry, A. A., & Hussein, R. R. (2021). A randomized trial to compare procalcitonin and C-reactive protein in assessing severity of sepsis and in guiding antibacterial therapy in Egyptian critically ill patients. *Irish Journal of Medical Science (1971-)*, 1-9.

Dimitrova-Karamfilova, A., Petrova, I., Tomova, N., & Mihailova, M. (2019).

Immunoturbidimetric assay for determination Procalcitonin-Analytical evaluation and comparison with C-reactive protein as a biomarker for systemic inflammation, infection, and sepsis. *Clinica chimica acta*, *493*, S26-S27.

Fioretto, J. R., Martin, J. G., Kurokawa, C. S., Carpi, M. F., Bonatto, R. C., de Moraes, M. A., & Ricchetti, S. M. (2010). Comparison between procalcitonin and C-reactive protein for early diagnosis of children with sepsis or septic shock. *Inflammation Research*, *59*, 581-586.

Golovnya, E., Kharitidi, T. Y., Sotnikov, A., Somonova, O., & Kushlinskii, N. (2022). Diagnostic levels of sepsis biomarkers in children with oncological diseases. *Klinicheskaia Laboratornaia Diagnostika*, *67*(1), 13-18.

Güleç, R. D., Arslan, F. D., Çalışkan, T., Şenoğlu, N., Yılmaz, N., Atalay, S., & Pirim, İ. (2022). Could presepsin be an alternative marker in the early diagnosis of sepsis in COVID-19? *Scandinavian Journal of Clinical and Laboratory Investigation*, *82*(2), 108-114.

Huang, N., Chen, J., Wei, Y., Liu, Y., Yuan, K., Chen, J., He, M., & Liu, N. (2022). Multi-marker approach using C-reactive protein, procalcitonin, neutrophil CD64 index for the prognosis of sepsis in intensive care unit: a retrospective cohort study. *BMC Infectious Diseases*, *22*(1), 662.

Knezevic Rangelov, S., & Jankovic, S. (2021). Accuracy of serum procalcitonin, C-reactive protein, and soluble CD14 subtype levels in diagnosis of sepsis in children.

Quan, Y., Liu, A.-f., Li, C., Jin, Y.-x., Liu, Y.-e., Zhou, J., Yin, X.-x., Li, X., Jin, M., & Lv, J. (2023). Factors influencing the rate of residual stenosis in athletic patients after endovascular intervention for symptomatic carotid artery stenosis. *Revista multidisciplinar de las Ciencias del Deporte*, *23*(89).

Rao, H., Dutta, S., Menon, P., Attri, S., Sachdeva, N., & Malik, M. (2022). Procalcitonin and C-reactive protein for diagnosing post-operative sepsis in neonates. *Journal of Paediatrics and Child Health*, *58*(4), 593-599.

Shang, Y.-X., Zheng, Z., Wang, M., Guo, H.-X., Chen, Y.-J., Wu, Y., Li, X., Li, Q., Cui, J.-Y., & Ren, X.-X. (2022). Diagnostic performance of Neutrophil CD64 index, procalcitonin, and C-reactive protein for early sepsis in hematological patients. *World Journal of Clinical Cases*, *10*(7), 2127.

Tanak, A. S., Jagannath, B., Tamrakar, Y., Muthukumar, S., & Prasad, S. (2019). Non-faradaic electrochemical impedimetric profiling of procalcitonin and C-reactive protein as a dual marker biosensor for early sepsis detection. *Analytica chimica acta: X*, *3*, 100029.

Uusitalo-Seppälä, R., Koskinen, P., Leino, A., Peuravuori, H., Vahlberg, T., & Rintala, E. M. (2011). Early detection of severe sepsis in the emergency room: diagnostic value of plasma C-reactive protein, procalcitonin, and interleukin-6. *Scandinavian journal of infectious diseases*, *43*(11-12), 883-890.

Wang, F., Ran, L., Qian, C., & Li, Q. (2020). Comparison of the Accuracy of Procalcitonin, Neutrophil CD64, and c-Reactive Protein for the Diagnosis and Prognosis of Septic Patients Who Received Antimicrobial Therapies. In *B45. CRITICAL CARE: SEPSIS IDENTIFICATION AND MANAGEMENT* (pp. A3488-A3488). American Thoracic Society.

Woo, A. I., Oh, D. K., Park, C.-J., & Hong, S.-B. (2021). Monocyte distribution width compared with C-reactive protein and procalcitonin for early sepsis detection in the emergency department. *PLoS One*, *16*(4), e0250101.

Zeng, G., Chen, D., Zhou, R., Zhao, X., Ye, C., Tao, H., Sheng, W., & Wu, Y. (2022). Combination of C-reactive protein, procalcitonin, IL-6, IL-8, and IL-10 for early diagnosis of hyperinflammatory state and organ dysfunction in pediatric sepsis. *Journal of Clinical Laboratory Analysis*, *36*(7), e24505.

Zhou, B., Huang, Y., Zhong, M., Zeng, C., & Wu, J. (2021). The Role of pSOFA Score Combined with C-Reactive Protein and Procalcitonin in the Prognostic Evaluation of Children with Sepsis: A Single-Center Cross-Sectional Study.