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Study on the Correlation between Multiple Serum Biochemical and Immune Indicators on the Severity of Chronic Heart Failure

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Abstract: *Objective:* To analyze the expression levels of multiple serum biochemical and immune indicators in patients with chronic heart failure, explore the correlation between each indicator and the severity of the patient's condition, and screen objective serological reference indicators that can be used to evaluate the grade and prognostic risk of heart failure. *Methods:* The research investigation period was from October 2024 to February 2026. The selected research subjects were 126 patients with chronic heart failure who were treated in our hospital. According to the New York Heart Association (NYHA) cardiac function classification standards, the patients were divided into the grade II group with 42 cases, the grade III group with 45 cases, and the grade IV group with 39 cases. In addition, 60 healthy people who underwent physical examination in our hospital during the same period were selected as the control group. Venous blood was collected from all study subjects on an empty stomach to detect serum uric acid (UA), creatinine (Scr), urea nitrogen (BUN), high-sensitivity C-reactive protein (hs-CRP), tumor necrosis factor-α (TNF-α), and interleukin-6 (IL-6) levels. The differences in indicators between heart failure patients with different cardiac function grades and healthy people were compared. Pearson correlation was used to analyze the relationship between each serum indicator and the severity of heart failure. *Results:* The serum UA, Scr, BUN, hs-CRP, TNF-α, and IL-6 levels of the patients in the observation group were all higher than those of the control group ($P < 0.05$); as the NYHA cardiac function class increased, the levels of various serum biochemical and immune-inflammatory indicators in the patients increased in a stepwise manner. The comparison difference value between grade II, grade III, and grade IV groups was $P<0.05$; Pearson correlation analysis results showed that serum UA, Scr, BUN, hs-CRP, TNF-α, and IL-6 levels were positively correlated with the severity of chronic heart failure. *Conclusion:* A number of serum biochemical and immune-inflammatory indicators are abnormally highly expressed in patients with chronic heart failure, and the expression levels of the indicators increase as the patient's cardiac function injury worsens, and are closely related to the severity of the disease. Clinically, the above serum indicators can be jointly detected to objectively evaluate the progression of heart failure patients, providing a reliable laboratory basis for clinical hierarchical diagnosis and treatment, intervention plan adjustment, and prognosis assessment.

Keywords: Chronic heart failure; Serum biochemical indicators; Immune and inflammatory indicators; NYHA classification; Disease severity; Correlation analysis

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1. Introduction

Chronic heart failure is a common clinical syndrome in which various cardiovascular diseases progress to the end stage [1]. It is also a high-risk critical condition in cardiology. It is mainly caused by long-term damage to myocardial function due to underlying heart diseases such as coronary heart disease, hypertensive heart disease, and cardiomyopathy. It has ventricular systolic and diastolic dysfunction, circulatory congestion, and insufficient tissue perfusion as its core pathological characteristics. The course of the disease is protracted and the condition is progressively worsening. Recurrent chest tightness, asthma, edema and other symptoms seriously affect the patient's quality of life. The long-term readmission rate and mortality rate remain high. It is a chronic disease that is currently the focus of prevention and control in the cardiovascular field. The current clinical assessment of the severity of chronic heart failure mainly relies on NYHA cardiac function classification, echocardiographic cardiac function indicators, and patient clinical symptoms and signs. Among them, NYHA classification is based on the patient's subjective activity tolerance as the core of the evaluation, and there is a certain degree of subjectivity. Although cardiac ultrasound examination can objectively reflect the structure and function of the heart, the examination takes a long time and cannot achieve rapid bedside assessment, which has certain application limitations. Therefore, finding serological indicators that are easy to measure, have objective results, and can accurately reflect the progression of the disease is of great significance to optimizing the clinical evaluation system for heart failure [2]. Existing clinical studies have confirmed that the progression of chronic heart failure is not only limited to myocardial structural and functional damage, but is also accompanied by systemic metabolic disorders and persistent low-grade inflammatory reactions. Decreased cardiac function will cause renal hypoperfusion, leading to abnormalities in the body's purine metabolism and renal function indicators. At the same time, myocardial ischemia, hypoxia, and tissue congestion will activate the body's immune inflammatory system and release a large amount of inflammatory factors, further aggravating myocardial cell damage and ventricular remodeling, forming a vicious cycle of worsening disease [3]. This study detects serum metabolism, renal function, immune and inflammatory indicators in patients with different disease grades of chronic heart failure, and systematically analyzes the correlation between each indicator and the severity of the disease, aiming to provide objective laboratory data support for accurate disease assessment and early risk intervention of chronic heart failure.

2. Materials and methods

2.1. General information

The data entry period is from October 2024 to February 2026. The set research goals are 126 patients with chronic heart failure who came from our hospital. They are called the observation group. They are grouped according to the NYHA cardiac function classification standard: 42 patients in the Class II group, male:female = 23:19, aged 52-78 years old. The average age was (65.32 ± 6.85) years old; there were 45 cases in the grade III group, 25 males and 20 females, aged 53 to 79 years old, with an average age of (66.15 ± 7.02) years old; there were 39 cases in the grade IV group, with a gender ratio of 21:18, aged 51 to 80 years old, with an average age of (64.98 ± 6.91) years old. Another 60 cases from the healthy physical examination population in our hospital during the same period were selected as healthy controls, with no underlying diseases and no acute or chronic infections. There were 32 males and 28 females, with the oldest being 79 years old and the youngest being 50 years old, with an average age of (65.05 ± 6.78) years. The above two

sets of data were compared through balanced calibration, and there was no significant difference ($P > 0.05$). This study was approved by the Medical Ethics Committee of our hospital, and all research subjects gave informed consent and signed their signatures for confirmation.

Inclusion criteria: (1) No use of anti-inflammatory or immunomodulatory drugs within 2 weeks before enrollment; (2) Age 50 to 80 years old; (3) No history of acute infection, trauma, or surgery; (4) Voluntary participation in this study. Exclusion criteria: (1) Patients with acute myocardial infarction, severe arrhythmia, and acute heart failure; (2) Patients with acute and chronic renal failure, autoimmune diseases, malignant tumors, and severe liver and lung diseases; (3) Patients with systemic infections, thrombotic diseases, and uncontrolled metabolic diseases; (4) Those who have recently received hormone and immunosuppressant treatment; (5) Those who are unable to cooperate with the test or drop out of the study midway.

2.2. Method

All research subjects collected 5 mL of cubital venous blood in the early morning on an empty stomach, placed it in a sterile anticoagulant test tube, left it at room temperature for 30 minutes, and then centrifuged it at 3000 r/min for 10 minutes to separate the serum and save it for testing. A fully automatic biochemical analyzer is used to detect serum biochemical indicators: uric acid (UA), blood creatinine (Scr), and urea nitrogen (BUN); an enzyme-linked immunosorbent assay (ELISA) is used to detect immune and inflammatory indicators: high-sensitivity C-reactive protein (hs-CRP), tumor necrosis factor-α (TNF-α), and interleukin-6 (IL-6). All testing operations strictly follow the instructions of the instrument and kit to ensure accurate and reliable test results.

2.3. Observation indicators

(1) Compare the differences in serum biochemical and immune index levels between the healthy control group and the heart failure observation group.
(2) Compare the index levels of heart failure patients with different conditions in NYHA II, III and IV.
(3) Analyze the correlation between various serum indicators and the severity of chronic heart failure.

2.4. Statistical methods

The data were imported into SPSS 27.0 software for verification. Measurement data were presented as mean ± standard deviation (SD), and the t-test was used; count data were presented as (%), and the χ^2 test was used; Pearson linear correlation analysis was used. The difference value is significant as $P<0.05$.

3. Results

3.1. Comparison of serum index levels between the two groups

The serum UA, Scr, BUN, hs-CRP, TNF-α, and IL-6 levels of patients in the chronic heart failure observation group were all higher than those in the control group ($P < 0.05$), **Table 1**.

Table 1. Comparison of serum index levels between the two groups (mean ± SD)

Group	n	UA (μmol/L)	Scr (μmol/L)	BUN (mmol/L)	hs-CRP (mg/L)	TNF-α (ng/L)	IL-6 (ng/L)
Observation group	126	458.62 ± 56.32	98.65 ± 12.86	8.96 ± 2.15	9.86 ± 2.35	28.95 ± 6.82	22.36 ±5 .18

Group	n	UA (μmol/L)	Scr (μmol/L)	BUN (mmol/L)	hs-CRP (mg/L)	TNF-α (ng/L)	IL-6 (ng/L)
Control group	60	286.35 ± 42.16	72.18 ± 10.35	5.12 ± 1.26	2.15 ± 0.68	12.36 ± 3.25	8.65 ± 2.12
t	-	20.862	14.258	12.965	25.689	18.356	20.125
P	-	0.000	0.000	0.000	0.000	0.000	0.000

3.2. Comparison of serum indicators in patients with heart failure of different NYHA grades

As the NYHA cardiac function class increased, patients' serum UA, Scr, BUN, hs-CRP, TNF-α, and IL-6 levels gradually increased, and the differences were statistically significant ($P < 0.05$), **Table 2**.

Table 2. Comparison of serum indicators in patients with heart failure of different NYHA grades (mean ± SD)

Group	n	UA (μmol/L)	Scr (μmol/L)	BUN (mmol/L)	hs-CRP (mg/L)	TNF-α (ng/L)	IL-6 (ng/L)
NYHAII Group	42	382.15 ± 48.26	85.32 ± 11.25	6.85 ± 1.62	6.25 ± 1.86	20.15 ± 5.26	15.32 ± 4.25
NYHAIII Group	45	465.82 ± 52.18	97.86 ± 12.18	8.92 ± 1.95	9.68 ± 2.12	29.36 ± 6.18	22.85 ± 4.96
NYHAIV Group	39	532.65 ± 58.35	112.35 ± 13.62	11.36 ± 2.32	13.25 ± 2.68	38.65 ± 7.32	29.68 ± 5.82

3.3. Correlation analysis between serum indicators and severity of heart failure

Serum UA, Scr, BUN, hs-CRP, TNF-α, and IL-6 levels were positively correlated with NYHA cardiac function classification of chronic heart failure ($P < 0.05$). **Table 3**.

Table 3. Correlation analysis between serum indicators and severity of heart failure (n,%)

Indicator	UA	Scr	BUN	hs-CRP	TNF-α	IL-6
r value	0.682	0.653	0.712	0.756	0.728	0.741
P value	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

4. Discussions

Chronic heart failure is an end-stage syndrome of cardiovascular disease. The progression of chronic heart failure is a complex pathological process of continuous superposition of myocardial damage, neuroendocrine activation, systemic metabolic disorders, and chronic inflammation. Accurately assessing the severity of a patient's condition is the key to clinically formulating individualized treatment plans and improving patient prognosis [4]. Traditional assessment methods have disadvantages such as strong subjectivity and cumbersome operations, and cannot quickly and dynamically reflect subtle changes in the condition. Serological testing has the advantages of convenience, objectivity, and repeatability, and can be used as an important supplementary method for heart failure assessment [5].

Research results show that serum renal function [6], metabolism and inflammation indicators in patients with chronic heart failure are higher than those in healthy people, and the indicator levels continue to increase with the increase in NYHA cardiac function class. Each indicator is positively correlated with the severity of the disease, fully confirming that multiple serological indicators can effectively reflect the progression of heart failure. From the analysis of biochemical metabolism and renal function indicators, UA, Scr, and

BUN are core indicators that reflect the body's metabolism and renal function. Patients with chronic heart failure have reduced cardiac function, insufficient cardiac output, reduced systemic effective circulating blood volume, reduced renal perfusion pressure, and impaired glomerular filtration function, resulting in the inability of the body to metabolize and excrete creatinine and urea nitrogen normally, resulting in increased accumulation of Scr and BUN. At the same time, myocardial hypoxia and tissue congestion will accelerate the body's purine catabolism, increase the production of uric acid, and reduce the excretion capacity of kidney function, eventually causing an abnormal increase in UA. Moreover, the more serious the patient's cardiac function damage is, the more serious the renal ischemia, hypoxia, and metabolic disorder, and the more obvious the increase in various biochemical indicators, which can indirectly reflect the severity of heart failure. hs-CRP, TNF-α, and IL-6 are core markers of the body's low-grade inflammatory response. IL-6 can directly induce myocardial cell apoptosis, aggravate myocardial fibrosis, and promote the progression of ventricular remodeling; TNF-α can inhibit myocardial contractile function and aggravate microcirculation disorders; hs-CRP, as an acute-phase response protein, can directly reflect the degree of inflammation activation in the body. The three are synergistically involved in the progression of heart failure. The more critical the condition, the stronger the body's inflammatory stress response and the higher the expression level of inflammatory factors, which is highly consistent with the data results of this study.

Correlation analysis further confirmed that the six serum indicators were moderately to highly positively correlated with heart failure, indicating that the higher the indicator value [7], the more severe the patient's cardiac function damage and the worse the prognosis. In clinical practice, the above indicators can be jointly detected to make up for the shortcomings of subjective evaluation of a single NYHA classification and achieve objective and quantitative assessment of the condition. At the same time, changes in indicators can be dynamically monitored to determine the patient's treatment effect and predict the risk of disease deterioration. Compared with single indicator detection, multiple indicator joint detection can reflect the pathological state of heart failure from multiple dimensions such as renal function damage, metabolic disorder, and inflammatory activation [8]. The evaluation results are more comprehensive and accurate, and can provide important reference for clinical hierarchical diagnosis and treatment, timely adjustment of cardiotonic, diuretic, anti-inflammatory, and improvement of ventricular remodeling treatment plans.

5. Conclusion

In summary, a number of serum biochemical and immune indicators are abnormally highly expressed in patients with chronic heart failure, and the levels of each indicator tend to increase with the worsening of cardiac function damage. Multi-indicator joint detection can improve the accuracy of heart failure assessment and is of great value in guiding individualized clinical treatment and improving the long-term prognosis of patients.

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Disclosure statement

The author declares no conflict of interest.

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