

Evaluation of Renal Dysfunction in Heart Failure Patients Based on Serum Levels of Gal-3 and IL-6

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Abstract: The objective of this study is to investigate the serum concentrations of Galectin-3 (Gal-3) and interleukin-6 (IL-6) in individuals with heart failure (HF) and to assess their relationship with markers of renal function. Between September 2021 and September 2023, 230 consecutive patients diagnosed with HF at the cardiovascular department of our institution were recruited. Venous blood samples were obtained from each participant to determine the serum levels of Gal-3 and IL-6. A subsequent analysis was conducted to explore the correlation between these biomarkers and renal function parameters. Our findings revealed a notable escalation in Gal-3 and IL-6 levels in serum as the cardiac functional grading increased. Additionally, a significant positive association was observed between these two biomarkers and crucial renal function indicators, specifically serum creatinine and urea nitrogen. Consequently, the serum levels of Gal-3 and IL-6 can serve as valuable reference markers for evaluating the renal status of HF patients. Monitoring these biomarkers enables clinicians to make a more informed assessment of renal function in HF patients, ultimately leading to the development of more tailored treatment strategies for these individuals.

1. Introduction

HF represents a multifaceted clinical syndrome marked by reduced cardiac pumping efficiency, leading to inadequate perfusion of bodily tissues and organs. As HF progresses, patients often develop renal dysfunction to varying degrees. This complication not only elevates mortality rates but also diminishes patients' quality of life significantly [1]. Previous research relied heavily on traditional renal function markers, such as serum creatinine and urea nitrogen, despite their limited sensitivity and specificity [2]. Recent advancements in proteomics and molecular biology have shone a spotlight on novel biomarkers, notably Gal-3 and IL-6 [3]. Gal-3, a lectin, plays a role in inflammatory responses and is closely tied to processes like myocardial fibrosis and ventricular remodeling. Elevated Gal-3 levels in HF patients have been linked to increased risks of adverse

cardiovascular events [4]. Meanwhile, IL-6, a proinflammatory cytokine, is pivotal in HF pathophysiology. Studies indicate that elevated serum IL-6 levels in HF patients correlate with the severity of left ventricular dysfunction and serve as an independent predictor of poor prognosis.

HF's pathophysiological progression involves intricate interactions among various mechanisms, including neurohormonal activation, inflammatory responses, oxidative stress, and apoptosis [5]. These mechanisms not only impact cardiac function but may also cause secondary damage to multiple organs, particularly the kidneys [6]. Renal dysfunction, especially in the later stages of HF, is common and often indicates a poorer prognosis [7]. Consequently, identifying biomarkers that accurately reflect renal function is crucial for the treatment and management of HF patients. This study aims to explore the utility of serum Gal-3 and IL-6 levels in assessing renal dysfunction among HF patients. By measuring these biomarkers, we analyzed their correlation with renal function indices, aiming to provide a more precise and sensitive evaluation method for clinical renal dysfunction, ultimately guiding treatment and enhancing patient prognosis.

2. Materials and methods

2.1. Research objects

From September 2021 to September 2023, this study consecutively enrolled 230 patients diagnosed with HF in the cardiovascular department of our hospital. The inclusion criteria included: 1) meeting the clinical diagnostic criteria for HF, which meant that patients exhibited typical symptoms of HF, such as dyspnea, fatigue, and fluid retention, confirmed by electrocardiogram, echocardiography, and other auxiliary examinations; 2) being older than 18 years old to ensure that the subjects possessed a certain degree of physiological and psychological resilience; 3) patients or their families signed informed consent forms to voluntarily participate in this study.

The exclusion criteria encompassed: 1) the presence of other severe chronic diseases, such as malignant tumors, cerebrovascular diseases, severe liver and kidney dysfunction, etc.; 2) recent immunosuppressive therapy or autoimmune diseases; 3) patients unable to cooperate to complete the required tests for this study, such as those with mental disorders or severe cognitive impairments.

2.2. Data collection and processing

After admission, the patient's basic information was recorded in detail, including age, gender, course of disease, and cardiac function grading (using NYHA grading standards). At the same time, comprehensive collection of clinical examination results from patients, such as electrocardiograms, echocardiography, etc., is conducted to evaluate the patient's cardiac function and structural changes. In addition, special attention should be paid to the patient's renal function indicators, such as serum creatinine, urea nitrogen, etc., to understand the patient's renal function status.

2.3. Detection of serum Gal-3 and IL-6 levels

Within the first 24 hours of the patient's hospitalization, a 5ml sample of venous blood was drawn and promptly centrifuged to isolate the serum. Following this, the concentrations of Gal-3 and IL-6 present in the serum were measured by employing the enzyme-linked immunosorbent assay (ELISA) method. To guarantee the precision of the test outcomes, the instructions provided by the reagent kit were rigorously adhered to, and testing was promptly initiated post-sampling to prevent any potential sample deterioration or contamination.

2.4. Data analysis methods

In our study, data were analyzed by utilizing SPSS 25.0 statistical software package. The quantitative data were expressed as mean \pm standard deviation ($\bar{x}\pm s$), and disparities between the two groups were evaluated using the t-test. Qualitative data were presented as percentages (%), and group comparisons were conducted via the χ^2 test. Additionally, to determine the correlation between serum Gal-3 and IL-6 levels and renal function indicators, we applied Pearson correlation analysis. A P-value less than 0.05 was considered statistically significant for all statistical tests performed.

2.5. Ethical considerations and approvals

This study strictly adheres to medical ethical standards and has been approved by the Ethics Committee of our hospital. Throughout the research process, the interests of patients have always been prioritized, fully protecting their privacy and right to know. At the same time, it also ensures the authenticity and reliability of the research data, providing a solid foundation for subsequent result analysis and discussion.

3. Results

The comprehensive data pertaining to patients, encompassing details such as gender, age, and NYHA cardiac function classification, has been meticulously organized and presented in Table 1. Our analysis reveals a marginal preponderance of male patients compared to female patients. Furthermore, the age range of the patients is quite diverse. An interesting observation is that as the cardiac function classification increases, there is a discernible upward trend in the average age of the patients. This suggests a potential correlation between advancing cardiac function classification and older age groups.

Table 1: Basic information of patients and cardiac function classification

Item	Total (n=230)	NYHA II (n=68)	NYHA III (n=92)	NYHA IV (n=70)
Male	130 (56.5%)	38 (55.9%)	52 (56.5%)	40 (57.1%)
Female	100 (43.5%)	30 (44.1%)	40 (43.5%)	30 (42.9%)
Age	65.8 \pm 10.3	63.2 \pm 9.8	66.4 \pm 10.5	67.5 \pm 10.7

Through the detection of serum Gal-3 and IL-6 levels in the entire patient cohort, we discovered a strong correlation between the concentrations of these biomarkers and the grading of cardiac function. Table 2 reveals a notable trend: as the cardiac function classification escalates, there is a significant rise in the mean serum levels of both Gal-3 and IL-6. This finding suggests a potential link between these two biomarkers and the progression of HF severity. Such a correlation implies that monitoring these markers could provide valuable insights into the clinical management and prognosis of HF patients.

Table 2: Relationship between serum Gal-3 and IL-6 levels and cardiac function grading

Cardiac function grading	Gal-3 level (ng/mL)	IL-6 level (pg/mL)
NYHA II	18.5 \pm 4.3	8.9 \pm 2.7
NYHA III	25.2 \pm 5.7	12.8 \pm 3.5
NYHA IV	31.4 \pm 6.9	17.6 \pm 4.8

To explore the relationship between serum Gal-3 and IL-6 concentrations and renal function, we undertook a comprehensive analysis to investigate their association with serum creatinine (SCr) and

blood urea nitrogen (BUN) levels. The results, summarized in Table 3, clearly indicate a strong positive correlation between the serum levels of Gal-3 and IL-6, and these two essential renal function markers. This finding implies that elevated serum levels of Gal-3 and IL-6 may signal a potential decline in renal function among patients. The observed correlation emphasizes the significance of tracking these biomarkers in evaluating and maintaining renal health status.

Table 3: Correlation between serum Gal-3 and IL-6 and renal function indexes

Indicator	Correlation with Gal-3 (r value)	Correlation with IL-6 (r value)
Serum creatinine (SCr)	0.65	0.50
Blood urea nitrogen (BUN)	0.55	0.42

4. Discussion

The value of serum Gal-3 and IL-6 as biomarkers in assessing renal dysfunction in patients with HF has received widespread attention in recent years. Through detailed analysis of 230 HF patients, this study further explored the correlation between these two markers and cardiac function classification as well as renal function indicators, providing a new perspective for clinical diagnosis and treatment.

4.1. Relationship between Serum Gal-3 and IL-6 and Cardiac Function Classification

The results indicated a significant increase in the average levels of serum Gal-3 and IL-6 as the cardiac function classification rose. This finding aligns with earlier research, suggesting a strong correlation between these two biomarkers and the gravity of HF. Cardiac function classification serves as a crucial metric for evaluating the state of HF patients. The surge in serum Gal-3 and IL-6 concentrations might signify the advancement of HF exacerbation and myocardial remodeling.

Gal-3, as a pivotal fibrosis-associated factor, occupies a central role in myocardial remodeling. When HF occurs, myocardial cells undergo damage, initiating inflammatory reactions and fibrosis processes, ultimately leading to myocardial structural and functional alterations. Gal-3 contributes to this process, driving fibrosis formation and progression, thereby compounding myocardial injury. Hence, escalated serum Gal-3 levels could potentially mirror the extent of myocardial fibrosis in HF patients, which is intricately linked to cardiac function classification.

Concurrently, IL-6, a vital inflammatory factor, holds significant importance in the pathogenesis of HF. As HF develops, the body mounts an inflammatory response, releasing copious amounts of inflammatory mediators, IL-6 among them. These factors perpetuate myocardial cell damage and functional decline, creating a negative feedback loop. Consequently, the rise in serum IL-6 levels might be tightly correlated with cardiac function classification, reflecting the severity of HF patients' condition.

4.2. Correlation between Serum Gal-3 and IL-6 and Renal Function Indicators

Our investigation also uncovered a notable direct relationship between serum Gal-3 and IL-6 concentrations and indicators of renal function, specifically serum creatinine and urea nitrogen levels. The findings imply that elevated levels of Gal-3 and IL-6 in the serum could be indicative of compromised renal function in patients.

Patients with HF often encounter renal issues, and any decline in renal function has the potential to worsen HF symptoms, perpetuating a negative spiral. Hence, timely identification and evaluation

of renal problems hold utmost importance in the effective treatment and oversight of HF patients. In this endeavor, serum Gal-3 and IL-6 emerge as promising biomarker candidates that could be pivotal in facilitating early detection and management of renal dysfunction in HF patients.

4.3. Research Limitations and Future Prospects

Notwithstanding the progress made in this study, there exist certain constraints. Primarily, as an observational undertaking, it cannot ascertain a causal linkage between the serum levels of Gal-3 and IL-6 and the grading of cardiac function or the occurrence of renal dysfunction. To delve deeper into this matter, further mechanistic investigations are warranted. Secondly, due to the relatively modest sample size of this study, there exists a potential for selection bias. To substantiate the findings of this research, more extensive prospective studies are required.

Moreover, the utilization of serum Gal-3 and IL-6 as biomarkers to gauge renal dysfunction in HF patients demands further examination. Future studies could concentrate on exploring the association between these biomarkers and other renal function indices (such as glomerular filtration rate, urinary protein, etc.), alongside their dynamic shifts as renal dysfunction progresses in HF patients. This line of inquiry holds promise for enhancing our understanding and management of renal complications in the context of heart failure.

In summary, our research revealed a significant correlation between serum Gal-3 and IL-6 concentrations and both cardiac function classification as well as renal function decline in heart failure patients. Elevated levels of these biomarkers could potentially indicate disease progression and renal dysfunction. Consequently, tracking the serum concentrations of Gal-3 and IL-6 offers clinicians a fresh viewpoint for assessing the renal status of heart failure patients, enabling timely adjustments to treatment strategies and potentially improving patient outcomes.

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