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Research Article

Role of NT-proBNP in Diagnosis and Prognostic Assessment of Heart Failure Patients

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ABSTRACT
Background: Heart failure (HF) is a major cause of morbidity, hospitalization, and mortality. N-terminal pro-B-type natriuretic peptide (NT-proBNP), released in response to increased myocardial wall stress, has emerged as an important biomarker for the diagnosis and risk stratification of HF. This study evaluated the diagnostic and prognostic role of NT-proBNP in patients with suspected heart failure.
Methods: This prospective observational study included 110 adult patients presenting with clinical features suggestive of HF. Clinical assessment, laboratory investigations, NT-proBNP measurement, and echocardiography were performed. Patients with confirmed HF were followed for 90 days to assess adverse clinical outcomes. Diagnostic performance was evaluated using receiver operating characteristic (ROC) curve analysis, and independent predictors of adverse outcomes were assessed using multivariate logistic regression.
Results: Heart failure was confirmed in 86 (78.2%) patients. Median NT-proBNP was significantly higher in patients with HF than in those without HF [2840 (1450–5870) vs 310 (165–590) pg/mL; p<0.001]. NT-proBNP increased progressively from NYHA class II to IV (p<0.001) and was highest among patients with HFrEF. At a cut-off of ≥900 pg/mL, NT-proBNP demonstrated an AUC of 0.91, sensitivity of 88.4%, specificity of 83.3%, and diagnostic accuracy of 87.3%. During 90-day follow-up, 28 (32.6%) HF patients experienced adverse outcomes. These patients had significantly higher baseline NT-proBNP [6180 vs 2310 pg/mL; p<0.001]. NT-proBNP ≥5000 pg/mL independently predicted adverse outcomes (AOR 3.18; 95% CI: 1.24–8.16; p=0.016).
Conclusion: NT-proBNP showed excellent diagnostic accuracy and significant prognostic value in patients with HF. Higher concentrations were associated with greater clinical severity, reduced LVEF, and adverse short-term outcomes, supporting its role as a useful adjunct in HF diagnosis and risk stratification.

Keywords: Nt-Probnp, Heart Failure, Biomarkers, Diagnosis, Prognosis, Left Ventricular Ejection Fraction, Nyha Functional Class.

INTRODUCTION

Heart failure (HF) is a complex clinical syndrome resulting from structural or functional cardiac abnormalities that impair ventricular filling or ejection of blood. It represents a major global health problem and is associated with substantial morbidity, recurrent hospitalization, impaired quality of life, and mortality.[1,2] Despite advances in pharmacological and device-based therapies, the clinical burden of HF remains considerable, particularly among elderly patients and those with multiple cardiovascular comorbidities.[3]

The diagnosis of HF can be challenging because its common manifestations, including dyspnea, fatigue, exercise intolerance, and peripheral edema, are relatively nonspecific and may occur in several cardiac and non-cardiac conditions.[4] Although echocardiography remains central to the evaluation of cardiac structure and function, accessibility, operator dependency, and difficulties in obtaining immediate imaging in some clinical settings have encouraged the use of circulating biomarkers to complement clinical assessment.[5]

N-terminal pro-B-type natriuretic peptide (NT-proBNP) has emerged as one of the most important biomarkers for the diagnosis and assessment of HF. It is released predominantly from ventricular cardiomyocytes in response to increased myocardial wall stress, ventricular volume expansion, and pressure overload.[6] Pro-B-type natriuretic peptide is cleaved into

biologically active B-type natriuretic peptide (BNP) and the biologically inactive N-terminal fragment, NT-proBNP. Because NT-proBNP has a relatively longer circulating half-life and is analytically stable, it is widely used in routine clinical practice.[7]

Circulating NT-proBNP concentrations are generally increased in patients with HF and are related to the severity of myocardial dysfunction and hemodynamic stress. Measurement of natriuretic peptides has therefore become an important component of the diagnostic evaluation of patients presenting with suspected HF, particularly those with unexplained acute or chronic dyspnea.[8] Low concentrations have high negative predictive value and can help exclude HF, whereas elevated concentrations support the diagnosis when interpreted in conjunction with clinical and echocardiographic findings.[9]

Beyond diagnosis, NT-proBNP provides important prognostic information. Higher concentrations have been associated with greater HF severity, reduced left ventricular ejection fraction (LVEF), recurrent hospitalization, and increased cardiovascular and all-cause mortality.[10] Serial changes in NT-proBNP may additionally reflect alterations in hemodynamic status and response to treatment, making it a potentially useful marker for risk stratification.[11]

Interpretation of NT-proBNP nevertheless requires consideration of several clinical factors. Concentrations increase with advancing age and renal dysfunction and may also be elevated in atrial fibrillation, pulmonary hypertension, acute coronary syndromes, and other conditions. Conversely, natriuretic peptide concentrations may be relatively lower in individuals with obesity.[5,12] Biomarker concentrations should therefore be interpreted within the overall clinical context rather than used as an isolated diagnostic criterion.

Considering the substantial burden of HF and the need for rapid diagnosis and early risk stratification, evaluation of NT-proBNP may facilitate identification of patients at increased risk of adverse outcomes and assist clinical decision-making. The present study was therefore undertaken to assess the diagnostic and prognostic role of NT-proBNP in patients with heart failure and to determine its relationship with clinical severity, echocardiographic parameters, and short-term outcomes.

MATERIALS AND METHODS

This was a prospective observational study conducted in the Department of Medicine and Cardiology at a tertiary care teaching hospital. Patients presenting with symptoms suggestive of heart failure were screened for eligibility and enrolled during the study period.A total of 110 adult patients presenting with clinical features suggestive of heart failure were included in the study. Patients were enrolled consecutively after obtaining written informed consent.

Inclusion Criteria

Patients fulfilling the following criteria were included:

1. Age ≥18 years.
2. Presence of symptoms or signs suggestive of heart failure, including dyspnea, orthopnea, paroxysmal nocturnal dyspnea, fatigue, raised jugular venous pressure, pulmonary crepitations, or peripheral edema.
3. Patients undergoing echocardiographic evaluation for suspected heart failure.
4. Willingness to participate and provide written informed consent.

Exclusion Criteria

Patients with the following conditions were excluded:

1. Acute myocardial infarction at presentation.
2. Severe renal impairment or patients undergoing dialysis.
3. Severe chronic liver disease.
4. Acute pulmonary embolism.
5. Severe sepsis or septic shock.
6. Known active malignancy.
7. Recent major cardiac surgery.
8. Patients unwilling to participate in the study.

Clinical Assessment

A detailed history was obtained from all participants, including age, sex, duration of symptoms, previous history of heart failure, hypertension, diabetes mellitus, coronary artery disease, smoking, chronic kidney disease, and relevant medication use.

All patients underwent a comprehensive physical examination. Heart rate, systolic and diastolic blood pressure, respiratory rate, oxygen saturation, jugular venous pressure, pulmonary crepitations, peripheral edema, and other clinical features of congestion were recorded.

Functional severity was classified according to the New York Heart Association (NYHA) functional classification.

Laboratory Investigations

Venous blood samples were collected under aseptic precautions. Laboratory investigations included complete blood count, serum creatinine, blood urea, serum electrolytes, blood glucose, liver function tests, and other investigations as clinically indicated.

Serum/plasma NT-proBNP was measured using a standardized immunoassay according to the manufacturer's instructions. Samples were collected as close as feasible to the initial clinical assessment and before substantial modification of HF therapy.

Measurement of NT-proBNP

NT-proBNP concentrations were expressed in pg/mL. The diagnostic interpretation of NT-proBNP was performed according to established guideline-recommended thresholds while taking into consideration age, renal function, and the clinical setting.

Patients were additionally categorized according to NT-proBNP concentrations for assessment of relationships with disease severity and clinical outcomes.

Echocardiographic Assessment

Transthoracic echocardiography was performed using standard techniques. The following parameters were recorded:

- Left ventricular ejection fraction (LVEF)
- Left ventricular dimensions
- Left atrial size
- Regional wall-motion abnormalities
- Diastolic function
- Right ventricular function
- Significant valvular abnormalities
- Other relevant structural cardiac abnormalities

Based on LVEF, HF was categorized as heart failure with reduced ejection fraction (HFrEF; LVEF ≤40%), heart failure with mildly reduced ejection fraction (HFmrEF; LVEF 41–49%), and heart failure with preserved ejection fraction (HFpEF; LVEF ≥50%), in conjunction with appropriate clinical evidence.

Diagnostic Assessment

The final diagnosis of HF was established on the basis of clinical evaluation and objective evidence of cardiac structural or functional abnormality, including echocardiographic findings, according to accepted diagnostic criteria.

The diagnostic performance of NT-proBNP was assessed by comparing NT-proBNP concentrations between patients with and without a final diagnosis of HF. Receiver operating characteristic (ROC) curve analysis was performed to determine the optimal diagnostic cut-off and corresponding sensitivity, specificity, positive predictive value, negative predictive value, and area under the ROC curve (AUC).

Prognostic Assessment and Follow-up

Patients diagnosed with HF were followed for **90 days** following the index evaluation. Clinical outcomes assessed included:

- In-hospital mortality
- Duration of hospital stay
- Requirement for intensive care
- Rehospitalization for worsening heart failure
- All-cause mortality
- Composite adverse clinical outcome

Baseline NT-proBNP concentrations were compared between patients with and without adverse outcomes.

Outcome Measures

The primary diagnostic outcome was the diagnostic performance of NT-proBNP for identifying HF.

The primary prognostic outcome was the association between baseline NT-proBNP concentration and adverse clinical outcomes during follow-up.

Secondary outcomes included the association of NT-proBNP with NYHA functional class, LVEF, HF phenotype, renal function, and duration of hospitalization.

Statistical Analysis

Data were analyzed using SPSS.26statistical software. Continuous variables were expressed as mean ± standard deviation or median with interquartile range (IQR), depending on their distribution. Categorical variables were presented as frequencies and percentages. Normality was assessed using the Shapiro–Wilk test.

Continuous variables between two groups were compared using the independent-samples t-test or Mann–Whitney U test, as appropriate. Comparisons across three or more groups were performed using ANOVA or the Kruskal–Wallis test. Categorical variables were compared using the Chi-square test or Fisher's exact test.

The relationship between NT-proBNP and LVEF, NYHA class, renal function, and other continuous parameters was evaluated using Pearson or Spearman correlation analysis. ROC

curve analysis was performed to determine the diagnostic and prognostic performance of NT-proBNP. AUC with 95% confidence intervals, optimal cut-off values, sensitivity, specificity, positive predictive value, and negative predictive value were calculated.

Multivariate logistic regression analysis was performed to identify independent predictors of adverse clinical outcomes. Adjusted odds ratios (AORs) with 95% confidence intervals were reported. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 110 patients presenting with clinical features suggestive of heart failure were included in the study. The mean age was 64.2 ± 11.6 years, and 64 (58.2%) patients were male. Hypertension was the most frequent comorbidity, present in 72 (65.5%) patients, followed by diabetes mellitus in 51 (46.4%) and coronary artery disease in 45 (40.9%). The most common presenting symptom was dyspnea (91.8%), followed by peripheral edema (58.2%) and orthopnea (52.7%) (Table 1).

Table 1. Baseline demographic and clinical characteristics of the study population (N=110)

Variable	Value
Age (years), mean ± SD	64.2 ± 11.6
Age ≥65 years, n (%)	57 (51.8)
Male sex, n (%)	64 (58.2)
Female sex, n (%)	46 (41.8)
Hypertension, n (%)	72 (65.5)
Diabetes mellitus, n (%)	51 (46.4)
Coronary artery disease, n (%)	45 (40.9)
Chronic kidney disease, n (%)	19 (17.3)
Current/former smoking, n (%)	39 (35.5)
Dyspnea, n (%)	101 (91.8)
Orthopnea, n (%)	58 (52.7)
Peripheral edema, n (%)	64 (58.2)
Heart rate (beats/min), mean ± SD	92.6 ± 17.4
Systolic BP (mmHg), mean ± SD	132.8 ± 22.6
Serum creatinine (mg/dL), mean ± SD	1.24 ± 0.42

Following comprehensive clinical and echocardiographic evaluation, heart failure was confirmed in 86 (78.2%) patients, while 24 (21.8%) did not meet the diagnostic criteria for HF. Among patients with confirmed HF, HFrEF was the most common phenotype, accounting for 43.0%, followed by HFpEF in 33.7% and HFmrEF in 23.3%. The mean LVEF among HF patients was 40.8 ± 12.6%. Median NT-proBNP was substantially higher in patients with confirmed HF compared with patients without HF [2840 (IQR 1450–5870) vs 310 (IQR 165–590) pg/mL; p<0.001] (Table 2).

Table 2. NT-proBNP and echocardiographic findings according to final diagnosis

Parameter	Heart failure (n=86)	No heart failure (n=24)	p-value
NT-proBNP (pg/mL), median (IQR)	2840 (1450–5870)	310 (165–590)	<0.001
LVEF (%), mean ± SD	40.8 ± 12.6	58.7 ± 5.8	<0.001
LVEF <50%, n (%)	57 (66.3)	2 (8.3)	<0.001
Left atrial enlargement, n (%)	56 (65.1)	5 (20.8)	<0.001
Diastolic dysfunction, n (%)	61 (70.9)	8 (33.3)	0.001
Regional wall-motion abnormality, n (%)	38 (44.2)	3 (12.5)	0.005

Among the 86 patients with confirmed HF, NT-proBNP concentrations increased progressively with clinical severity. Median NT-proBNP increased from 1180 pg/mL in NYHA class II to 2980 pg/mL in class III and 6720 pg/mL in class IV (p<0.001). Patients with HFrEF also had higher NT-proBNP concentrations than those with HFmrEF or HFpEF (p<0.001) (Table 3).

Table 3. Association of NT-proBNP with clinical severity and heart failure phenotype (n=86)

Clinical category	N (%)	NT-proBNP (pg/mL), median (IQR)	p-value
NYHA functional class			**<0.001**
NYHA II	24 (27.9)	1180 (760–1840)	
NYHA III	38 (44.2)	2980 (1780–4560)	
NYHA IV	24 (27.9)	6720 (4210–9860)	
HF phenotype			**<0.001**
HFrEF (LVEF ≤40%)	37 (43.0)	4580 (2650–7380)	
HFmrEF (LVEF 41–49%)	20 (23.3)	2470 (1390–3880)	
HFpEF (LVEF ≥50%)	29 (33.7)	1680 (920–3150)	

NT-proBNP demonstrated excellent diagnostic performance for identifying HF. ROC curve analysis yielded an AUC of 0.91 (95% CI: 0.85–0.97; p<0.001). At an optimal cut-off of ≥900 pg/mL, NT-proBNP demonstrated a sensitivity of 88.4%, specificity of 83.3%, positive predictive value of 95.0%, and negative predictive value of 66.7% (Table 4).

Table 4. Diagnostic performance of NT-proBNP for heart failure

Diagnostic parameter	Value
Optimal NT-proBNP cut-off	≥900 pg/mL
AUC	0.91
95% CI	0.85–0.97
p-value	<0.001
Sensitivity	88.4%
Specificity	83.3%
Positive predictive value	95.0%
Negative predictive value	66.7%
Diagnostic accuracy	87.3%

During the 90-day follow-up, 28 (32.6%) of the 86 HF patients experienced the composite adverse outcome, whereas 58 (67.4%) remained free from an adverse event. Patients experiencing adverse outcomes were older, had a higher prevalence of NYHA class IV symptoms, lower LVEF, and higher serum creatinine. Median baseline NT-proBNP was more than two-fold higher among patients with adverse outcomes [6180 (IQR 3980–9450) vs 2310 (IQR 1210–3860) pg/mL; p<0.001] (Table 5).

Table 5. Comparison of heart failure patients according to 90-day adverse clinical outcome

Variable	No adverse outcome (n=58)	Adverse outcome (n=28)	p-value
Age (years), mean ± SD	61.8 ± 10.7	68.9 ± 11.2	0.006
Male sex, n (%)	32 (55.2)	19 (67.9)	0.26
Diabetes mellitus, n (%)	25 (43.1)	17 (60.7)	0.13
NYHA class IV, n (%)	10 (17.2)	14 (50.0)	0.001
LVEF (%), mean ± SD	43.5 ± 11.8	35.2 ± 12.4	0.004
Creatinine (mg/dL), mean ± SD	1.18 ± 0.36	1.46 ± 0.48	0.003
NT-proBNP (pg/mL), median (IQR)	2310 (1210–3860)	6180 (3980–9450)	<0.001
Hospital stay (days), median (IQR)	5 (4–7)	9 (6–12)	<0.001

Multivariate logistic regression analysis was performed to identify independent predictors of adverse outcomes. NT-proBNP ≥5000 pg/mL was independently associated with approximately three-fold higher odds of an adverse outcome (AOR 3.18; 95% CI: 1.24–8.16; p=0.016). NYHA class IV and LVEF ≤35% were also independent predictors. Although age ≥65 years and elevated creatinine showed increased odds of adverse outcomes, their associations did not reach statistical significance after adjustment (Table 6).

Table 6. Multivariate logistic regression analysis of predictors of adverse clinical outcomes

Predictor	Adjusted OR	95% CI	p-value
Age ≥65 years	1.72	0.69–4.29	0.245
NYHA class IV	2.86	1.10–7.43	0.031
LVEF ≤35%	2.63	1.05–6.59	0.039
Creatinine ≥1.5 mg/dL	1.89	0.72–4.96	0.196
NT-proBNP ≥5000 pg/mL	3.18	1.24–8.16	0.016

Overall, NT-proBNP demonstrated a strong association with both the presence and severity of heart failure. NT-proBNP concentrations increased progressively with worsening NYHA functional class and were highest among patients with HFrEF. The biomarker demonstrated excellent diagnostic discrimination for HF, with an AUC of 0.91. Furthermore, substantially elevated baseline NT-proBNP was independently associated with adverse 90-day outcomes, supporting its potential utility for both diagnostic evaluation and short-term prognostic risk stratification in patients with heart failure.

DISCUSSION

The present study evaluated the diagnostic and prognostic utility of NT-proBNP among 110 patients presenting with clinical features suggestive of heart failure (HF). Heart failure was confirmed in 86 (78.2%) patients, while 24 (21.8%) did not meet the diagnostic criteria. The principal findings were that NT-proBNP levels were significantly higher in patients with confirmed HF, increased progressively with worsening NYHA functional class, and were associated with left ventricular systolic dysfunction. NT-proBNP also demonstrated excellent diagnostic discrimination and independently predicted adverse clinical outcomes during 90-day follow-up.

The mean age of the study population was 64.2 ± 11.6 years, and 58.2% were male. Hypertension (65.5%), diabetes mellitus (46.4%), and coronary artery disease (40.9%) were the major comorbidities. This clinical profile is consistent with contemporary HF populations, in which advancing age, hypertension, diabetes, and ischemic heart disease represent important contributors to the development and progression of HF.[13] Savarese et al. also emphasized the substantial burden of HF among older individuals and the important contribution of cardiometabolic comorbidities to its increasing prevalence worldwide.[14]

In the present study, median NT-proBNP was markedly higher among patients with confirmed HF than among those without HF [2840 (1450–5870) vs 310 (165–590) pg/mL; p<0.001]. This finding supports the established physiological relationship between increased ventricular wall stress and natriuretic peptide release. Januzzi et al., in the PRIDE study, demonstrated that NT-proBNP measurement significantly improved the diagnostic assessment of patients presenting with acute dyspnea and showed high accuracy for identifying acute congestive HF.[15] Similarly, the International Collaborative of NT-proBNP Study demonstrated the usefulness of age-stratified NT-proBNP concentrations for diagnosing acute HF in patients presenting with dyspnea.[16]

ROC curve analysis in the present study demonstrated excellent diagnostic performance, with an AUC of 0.91 (95% CI: 0.85–0.97; p<0.001). At an optimal cut-off of ≥900 pg/mL, NT-proBNP showed a sensitivity of 88.4%, specificity of 83.3%, and overall diagnostic accuracy of 87.3%. These observations are comparable with previous investigations demonstrating high diagnostic accuracy of natriuretic peptides in suspected HF.[15,16] The high positive predictive value observed in our study further supports the usefulness of NT-proBNP when interpreted in a population with a relatively high pre-test probability of HF.

An important finding was the progressive increase in NT-proBNP with worsening clinical severity. Median concentrations increased from 1180 pg/mL in NYHA class II to 2980 pg/mL in NYHA class III and 6720 pg/mL in NYHA class IV (p<0.001). This stepwise increase reflects progressively greater myocardial wall stress and hemodynamic impairment with worsening HF. Masson et al. demonstrated that NT-proBNP concentrations were strongly related to disease severity and clinical outcomes in patients with chronic HF.[17] These findings suggest that NT-proBNP provides information not only regarding the presence of HF but also regarding its clinical severity.

NT-proBNP concentrations also differed significantly according to HF phenotype. Patients with HFrEF had the highest median

concentration (4580 pg/mL), followed by HFmrEF (2470 pg/mL) and HFpEF (1680 pg/mL; p<0.001). The lower concentrations observed in HFpEF compared with HFrEF are consistent with previous evidence showing that natriuretic peptide concentrations are generally lower in HFpEF despite clinically significant HF.[18] Nevertheless, elevated NT-proBNP remains diagnostically and prognostically relevant across the spectrum of LVEF.

Echocardiographic assessment demonstrated a mean LVEF of 40.8 ± 12.6% among patients with HF compared with 58.7 ± 5.8% among those without HF (p<0.001). Approximately two-thirds of patients with HF had LVEF <50%. The relationship between higher NT-proBNP concentrations and impaired systolic function observed in the present study is biologically plausible because ventricular dilatation and increased filling pressures stimulate natriuretic peptide secretion. Troughton et al. demonstrated the relationship between natriuretic peptide concentrations, cardiac function, and HF severity and highlighted their potential role in the assessment of HF patients.[19]

Beyond its diagnostic utility, the present study demonstrated an important prognostic role for NT-proBNP. During 90-day follow-up, 28 (32.6%) patients with HF experienced an adverse clinical outcome. Median baseline NT-proBNP was substantially higher among patients experiencing adverse outcomes than among those without adverse outcomes [6180 (3980–9450) vs 2310 (1210–3860) pg/mL; p<0.001]. Patients with adverse outcomes also had longer hospitalization, lower LVEF, higher serum creatinine, and a greater frequency of NYHA class IV symptoms.

These findings are supported by previous studies demonstrating that increased NT-proBNP is associated with mortality and rehospitalization in HF. Hartmann et al. reported that NT-proBNP was a strong predictor of mortality and morbidity among patients with chronic HF.[20] Similarly, Salah et al. demonstrated that NT-proBNP concentrations obtained in patients hospitalized with acute HF provided significant prognostic information regarding subsequent mortality and readmission.[21] Thus, markedly elevated NT-proBNP may identify patients requiring closer clinical monitoring and more intensive optimization of HF therapy.

On multivariate analysis, NT-proBNP ≥5000 pg/mL remained independently associated with adverse clinical outcomes (AOR 3.18; 95% CI: 1.24–8.16; p=0.016). NYHA class IV (AOR 2.86) and LVEF ≤35% (AOR 2.63) were also independent predictors. The persistence of NT-proBNP as a predictor after adjustment for clinical severity and ventricular function indicates that it may provide prognostic information complementary to conventional clinical and echocardiographic assessment. Previous systematic evaluations have similarly demonstrated a graded relationship between increasing natriuretic peptide concentrations and the risk of mortality and HF-related hospitalization.[22]

Renal function is an important consideration when interpreting NT-proBNP. In the present study, patients with adverse outcomes had significantly higher serum creatinine than those without adverse outcomes (1.46 ± 0.48 vs 1.18 ± 0.36 mg/dL; p=0.003). NT-proBNP concentrations may increase with declining renal function because of both reduced clearance and the high prevalence of structural cardiac disease and volume overload in patients with renal impairment.[23] Consequently, an elevated NT-proBNP value should always be interpreted in conjunction with age, renal function, rhythm, body mass index, and overall clinical presentation.

Current HF guidelines recommend measurement of BNP or NT-proBNP as part of the diagnostic evaluation of patients with suspected HF, particularly when the diagnosis is uncertain. Natriuretic peptide measurement is particularly useful for excluding HF when concentrations are low, while elevated concentrations should prompt comprehensive clinical and echocardiographic assessment.[24] The findings of the present study support this integrated approach rather than the use of a single NT-proBNP threshold as an isolated diagnostic criterion.The clinical utility of NT-proBNP arises from its ability to provide rapid, objective, and quantitative information regarding myocardial stress. In settings where symptoms such as dyspnea and edema may have multiple etiologies, NT-proBNP can complement clinical examination and echocardiography. Furthermore, markedly elevated concentrations may identify patients at greater risk of early deterioration, prolonged hospitalization, rehospitalization, or death.

CONCLUSION

NT-proBNP demonstrated excellent diagnostic performance for heart failure and showed a significant association with clinical and echocardiographic disease severity. Higher NT-proBNP levels were associated with worsening

NYHA class, reduced LVEF, and adverse 90-day outcomes. NT-proBNP may therefore serve as a useful adjunct for both diagnosis and early prognostic risk stratification in patients with heart failure.

Limitations

The study was limited by its single-centre design and relatively small sample size of 110 patients. The follow-up period of 90 days restricted assessment of long-term cardiovascular outcomes. Additionally, NT-proBNP concentrations may have been influenced by factors such as age, renal function, obesity, and other comorbid conditions despite clinical adjustment.

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