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NT-PROBNP LEVELS AND ASSOCIATED CLINICAL AND PARACLINICAL FACTORS IN PATIENTS WITH HEART FAILURE

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ABSTRACT

Objective: To describe NT-proBNP levels and investigate the associations between NT-proBNP and renal function as well as selected clinical and paraclinical characteristics in patients with heart failure. **Materials and Methods:** The study was conducted in 72 patients with heart failure at Can Tho Central General Hospital from August 2025 to May 2026. **Results:** Among the 72 patients, NT-proBNP levels were significantly higher in those with valvular heart disease than in those without valvular heart disease [4105 (2237–7816) vs. 2701 (717.5–5854.5) pg/mL; p = 0.029], whereas no significant differences were observed according to age, sex, BMI, or the other investigated comorbidities. NT-proBNP levels were higher in patients with LVEF ≤40% than in those with LVEF >40%, although this difference was not statistically significant [6144.5 (896–9262) vs. 2893 (1064.5–5859.5) pg/mL; p = 0.496]. In contrast, patients with eGFR <60 mL/min/1.73 m² had significantly higher NT-proBNP levels than those with eGFR ≥60 mL/min/1.73 m² [4459 (2380–8614) vs. 2150 (728.5–3318.5) pg/mL; p = 0.001]. NT-proBNP showed a weak positive correlation with serum creatinine (r_s = 0.260; p = 0.028) and a weak inverse correlation with eGFR (r_s = −0.327; p = 0.005), while no significant correlations were observed with LVEF, heart rate, or systolic blood pressure. **Conclusion:** In patients with heart failure, NT-proBNP levels were associated with renal function and were higher in patients with reduced eGFR.

Keywords: NT-proBNP, heart failure, renal function, eGFR, left ventricular ejection fraction.

INTRODUCTION

Heart failure (HF) is a complex clinical syndrome associated with substantial morbidity and hospitalization, particularly among older adults and patients with multiple comorbidities [1-5]. Its assessment requires integration of clinical findings, cardiac imaging, and laboratory biomarkers [4,5].

N-terminal pro-B-type natriuretic peptide (NT-proBNP) is widely used in the evaluation of HF. Released in response to increased myocardial wall stress, NT-proBNP provides useful information for the diagnosis and clinical assessment of patients with HF [6,7]. Previous studies have also demonstrated its clinical and prognostic value in different HF populations [3,8,11].

However, NT-proBNP concentrations may be influenced by factors other than cardiac dysfunction. Renal function is particularly important because reduced renal clearance may contribute to elevated NT-proBNP levels [9]. Other clinical characteristics and cardiovascular comorbidities may also affect its concentration [6,10]. Therefore, NT-proBNP should be interpreted together with the patient's clinical and laboratory findings. This study aimed to describe NT-proBNP levels and investigate their associations with renal function and selected clinical and paraclinical characteristics in patients with heart failure.

MATERIALS AND METHODS

Materials

A descriptive cross-sectional study was conducted among 72 patients with heart failure treated at Can Tho Central General Hospital, Vietnam, from August 2025 to May 2026. Patients diagnosed with heart failure who underwent clinical assessment, measurement of serum NT-proBNP and renal function, and echocardiographic evaluation during the study period were included. Patients with incomplete clinical, laboratory, or echocardiographic data required for the study analyses were excluded. The study aimed to describe NT-proBNP levels and evaluate their associations with renal function and selected clinical and paraclinical characteristics.

Methods

Demographic and clinical data were collected using a standardized study form. Variables included age, sex, body mass index (BMI), New York Heart Association (NYHA) functional class, heart rate, systolic blood pressure, and relevant comorbidities, including hypertension, diabetes mellitus, dyslipidemia, previous myocardial infarction, coronary artery disease, atrial fibrillation, valvular heart disease, hypertensive emergency, and infection.

Serum NT-proBNP concentrations were measured using a commercially available Human NT-proBNP (N-Terminal Pro-Brain Natriuretic Peptide) ELISA Kit (Elabscience, Cat. No. E-EL-H6126) according to the manufacturer's instructions. The assay was based on the sandwich ELISA principle. Optical density was measured at 450 ± 2 nm, and NT-proBNP concentrations were calculated from the standard curve. After measurement, NT-proBNP concentrations were converted from ng/mL to pg/mL (1 ng/mL = 1,000 pg/mL) for data analysis and reporting.

Serum creatinine was measured as part of the biochemical assessment, and renal function was evaluated using the estimated glomerular filtration rate (eGFR). Patients were categorized into two groups according to renal function: eGFR ≥60 mL/min/1.73 m² and eGFR <60 mL/min/1.73 m². Cardiac function was assessed by echocardiography using left ventricular ejection fraction (LVEF), with

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patients categorized as LVEF ≤40% or LVEF >40% for subgroup analyses

Statistic

Data were analyzed using IBM SPSS Statistics version 25.0. Continuous variables with an approximately normal distribution were presented as mean ± standard deviation (SD), whereas non-normally distributed variables were presented as median and interquartile range (IQR). Categorical variables were expressed as frequencies and percentages.

NT-proBNP concentrations were compared between two independent groups using the Mann–Whitney U test and among more than two groups using the Kruskal–Wallis test, as appropriate. Normally distributed continuous variables were compared between two groups using the independent-samples t-test. Associations between NT-proBNP levels and LVEF, serum creatinine, eGFR, heart rate, and systolic blood pressure were assessed using Spearman's rank correlation coefficient (r_s). All statistical tests were two-sided, and a p-value <0.05 was considered statistically significant.

Research Ethics

The study was approved by the Biomedical Research Ethics Committee of Can Tho University of Medicine and Pharmacy (Approval No. 25.326.HV/PCT-HĐĐĐ, dated June 30, 2025). All participants were informed about the study objectives and procedures and provided informed consent before participation. Patient information was kept confidential and used solely for research purposes

RESULTS

Clinical characteristics and NT-proBNP levels

Table 1. NT-proBNP levels according to clinical characteristics and comorbidities in patients with heart failure (n= 72)

Variable	NT-proBNP, pg/mL median (IQR)	p-value
Age (years)		
≤ 60 (n=16)	2757.5 (844.5 – 4872.5)	0.542
> 60 (n=56)	3175.5 (1203 – 6429.5)	
Sex		
Male (n=36)	2836 (1135.5 – 5939.75)	0.665
Female (n=36)	3365.5 (1064.5 – 6400)	
BMI category, kg/m²		
Underweight (n=11)	3500 (648 – 5567)	0.979
Normal weight (n=32)	3141.5 (1823.75 – 7500)	
Overweight (n=13)	3120 (1057 – 7437)	
Obesity (n=16)	2836 (993.75 – 5477.5)	
Hypertension		
Yes (n=67)	2966 (1596 – 6142)	0.698
No (n=5)	1042 (630.5 – 11406.5)	
Diabetes mellitus		
Yes (n=25)	2679 (704.5 – 8160)	0.813
No (n=47)	3120 (1596 – 5344)	
Dyslipidemia		
Yes (n=50)	2720.5 (777.5 – 6171.5)	0.285
No (n=22)	3553.5 (2064.5 – 6818.5)	
Myocardial infarction		
Yes (n=21)	2380 (599.5 – 5619.5)	0.144
No (n=51)	3447 (1821 – 6486)	
Coronary artery disease		
Yes(n=45)	2719 (772 – 6049.5)	0.231
No (n=27)	3500 (1738 – 6882)	
Atrial fibrillation		
Yes (n=17)	2380 (1710 – 5915)	0.765
No (n=55)	3231 (1029 – 6260)	
Valvular heart disease		
Yes (n=23)	4105 (2237 – 7816)	0.029
No (n=49)	2701 (717.5 – 5854.5)	
Hypertensive emergency		
Yes (n=10)	3090.5 (2222.75 – 12820)	0.241
No (n=62)	2901 (1017.25 – 6171.5)	
Infection		
Yes (n=21)	3500 (1319 – 7970)	0.446
No (n=51)	2722 (1062 – 6260)	

A total of 72 patients with heart failure were included in the study. NT-proBNP concentrations showed considerable variability across the clinical subgroups (Table 1). No statistically significant differences in NT-proBNP levels were observed according to age, sex, BMI category, hypertension, diabetes mellitus, dyslipidemia, previous myocardial infarction, coronary artery disease, atrial fibrillation, hypertensive emergency, or infection (all p > 0.05).

Patients with valvular heart disease had significantly higher NT-proBNP levels than those without valvular heart disease [4105 (2237–7816) vs. 2701 (717.5–5854.5) pg/mL; p = 0.029].

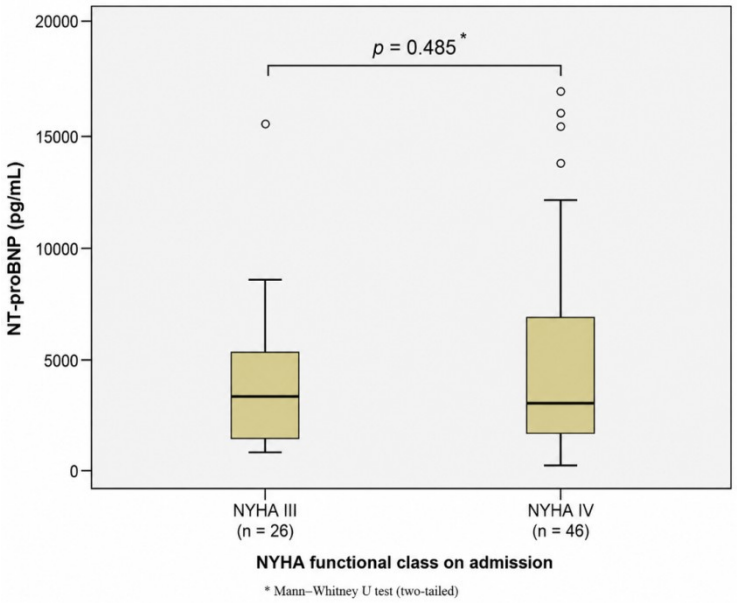

Figure 1. NT-proBNP levels according to NYHA functional class

NT-proBNP concentrations showed a wide distribution in both NYHA class III and IV, with no statistically significant difference between the two functional classes (p = 0.485) (Figure 1).

NT-proBNP levels according to cardiac and renal function

Table 2. NT-proBNP levels and renal function parameters according to left ventricular ejection fraction (n = 72)

Variable	LVEF ≤ 40% (n=8)	LVEF > 40% (n=64)	p-value
NT-proBNP, pg/mL median (IQR)	6144.5 (896 – 9262)	2893 (1064.5 – 5859.5)	0.496
Creatinin median (IQR)	100.5 (92 – 115.5)	104 (84.5 – 142.75)	0.781

eGFR, mL/min/1.73m² mean ± SD	31.75 ± 5.23	56.44 ± 7.65	<0.001

Patients with LVEF ≤40% had numerically higher NT-proBNP levels than those with LVEF >40% [6144.5 (896–9262) vs. 2893 (1064.5–5859.5) pg/mL]; however, the difference was not statistically significant (p = 0.496). Serum creatinine levels were also comparable between the two groups (p = 0.781). In contrast, eGFR was significantly lower in patients with LVEF ≤40% than in those with LVEF >40% (31.75 ± 5.23 vs. 56.44 ± 7.65 mL/min/1.73 m²; p < 0.001) (Table 2).

Table 3. NT-proBNP levels, serum creatinine, and left ventricular ejection fraction according to renal function (n = 72)

Variable	eGFR ≥ 60 (n=33)	eGFR < 60 (n=39)	p-value
NT-proBNP, pg/mL	2150 (728.5 – 3318.5)	4459 (2380 – 8614)	0.001
Creatinin	88 (71.5 – 95)	126 (108 – 182)	<0.001
LVEF (%)	54.06 ± 10.12	53.38 ± 11.39	0.793

When patients were stratified according to renal function, those with eGFR <60 mL/min/1.73 m² had significantly higher NT-proBNP concentrations than those with eGFR ≥60 mL/min/1.73 m² [4459 (2380–8614) vs. 2150 (728.5–3318.5) pg/mL; p = 0.001]. Serum creatinine was also significantly higher in the eGFR <60 group [126 (108–182) vs. 88 (71.5–95); p < 0.001]. In contrast, LVEF was similar between patients with eGFR <60 and ≥60 mL/min/1.73 m² (53.38 ± 11.39% vs. 54.06 ± 10.12%; p = 0.793) (Table 3).

Correlations of NT-proBNP with cardiac, renal, and hemodynamic parameters

Table 4. Correlations of NT-proBNP levels with cardiac, renal, and hemodynamic parameters (n = 72)

Variable	Spearman's correlation coefficient (r_s)	p-value
LVEF (%)	-0.039	0.748
Creatinin	0.260	0.028
eGFR	-0.327	0.005
Heart rate	0.073	0.542
Systolic blood pressure	0.083	0.486

Spearman correlation analysis showed that NT-proBNP was weakly positively correlated with serum creatinine (r_s = 0.260, p = 0.028) and weakly inversely correlated with eGFR (r_s = −0.327, p = 0.005). No statistically significant correlations were observed between NT-proBNP and LVEF (r_s = −0.039, p = 0.748), heart rate (r_s = 0.073, p = 0.542), or systolic blood pressure (r_s = 0.083, p = 0.486) (Table 4)

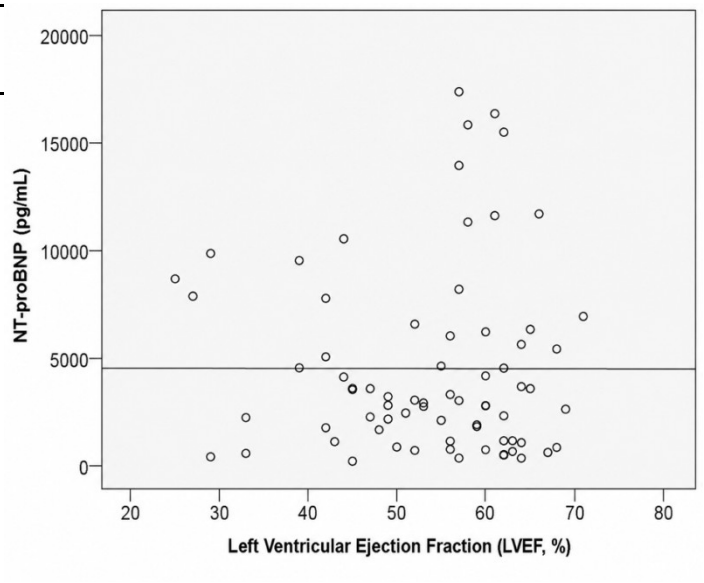

Figure 2. Relationship between NT-proBNP levels and left ventricular ejection fraction

The scatter plot showed a wide distribution of NT-proBNP concentrations across LVEF values, without a clear increasing or decreasing trend (Figure 2), consistent with the absence of a significant correlation between NT-proBNP and LVEF.

DISCUSSION

In this study of 72 patients with heart failure, NT-proBNP concentrations varied across clinical and paraclinical characteristics. A higher NT-proBNP level was observed in patients with valvular heart disease than in those without valvular heart disease. NT-proBNP levels were also higher in patients with reduced renal function, whereas no significant difference was found between the LVEF groups. In correlation analyses, NT-proBNP was weakly correlated with serum creatinine and eGFR but not with LVEF, heart rate, or systolic blood pressure.

NT-proBNP is commonly used as a biomarker in the clinical assessment of heart failure. Its concentration reflects myocardial wall stress but may also vary according to several clinical conditions and patient characteristics [6,7,10]. In the present study, NT-proBNP levels did not differ significantly according to age, sex, BMI, hypertension, diabetes mellitus, dyslipidemia, previous myocardial infarction, coronary artery disease, atrial fibrillation, hypertensive emergency, or infection. Similar to previous reports, the wide variation in NT-proBNP levels observed among patients suggests that its concentration should be considered together with the overall clinical context rather than interpreted in isolation [6,10].

Patients with valvular heart disease had higher NT-proBNP concentrations than those without valvular heart disease [4105 (2237–7816) vs. 2701 (717.5–5854.5) pg/mL; p = 0.029]. This finding may be related to changes in cardiac pressure and volume associated with valvular abnormalities, which can contribute to myocardial wall stress and natriuretic peptide release [6,10]. However, the type and severity of valvular heart disease were not evaluated separately in this study. Therefore, this finding should be interpreted as an observed difference between the two groups rather than evidence of an independent association.

NT-proBNP levels were higher in patients with LVEF ≤40% than in those with LVEF >40%, although the difference was not statistically

significant [6144.5 (896–9262) vs. 2893 (1064.5–5859.5) pg/mL; p = 0.496]. In addition, no significant correlation was observed between NT-proBNP and LVEF (r_s = −0.039; p = 0.748). NT-proBNP and LVEF represent different aspects of heart failure assessment: NT-proBNP reflects myocardial wall stress, whereas LVEF provides information on left ventricular systolic function [4–6]. The small number of patients with LVEF ≤40% (n = 8) may also have limited the ability to identify differences between the two LVEF groups. Thus, the present findings regarding LVEF should be interpreted cautiously.

A clearer difference in NT-proBNP concentration was observed according to renal function. Patients with eGFR <60 mL/min/1.73 m² had higher NT-proBNP levels than those with eGFR ≥60 mL/min/1.73 m² [4459 (2380–8614) vs. 2150 (728.5–3318.5) pg/mL; p = 0.001]. NT-proBNP was also weakly positively correlated with serum creatinine (r_s = 0.260; p = 0.028) and weakly inversely correlated with eGFR (r_s = −0.327; p = 0.005).

The relationship between NT-proBNP and renal function has been reported previously. Tsutamoto et al. found that renal clearance of NT-proBNP decreased with worsening renal function [9]. Therefore, reduced renal clearance may partly contribute to higher circulating NT-proBNP concentrations in patients with impaired kidney function. Current heart failure guidelines also recognize that natriuretic peptide concentrations may be affected by clinical factors other than cardiac function [4,5]. The findings of the present study are generally consistent with these observations and suggest that renal function should be considered when interpreting NT-proBNP concentrations in patients with heart failure. However, because the present analysis was cross-sectional, it cannot determine the direction or independence of this relationship.

Previous studies have reported the clinical value of NT-proBNP in patients with heart failure [3,7,8,11]. Studies conducted in Vietnam have also described NT-proBNP concentrations and their clinical relevance in patients with heart failure [1–3,11]. The present study adds descriptive data from patients treated at Can Tho Central General Hospital, particularly regarding the distribution of NT-proBNP according to renal function and selected clinical characteristics. Differences between studies may be related to patient characteristics, severity of heart failure, renal function, comorbidities, and methods of NT-proBNP measurement.

This study has several limitations. The sample size was relatively small and patients were recruited from a single center. Some subgroups contained few patients, particularly the LVEF ≤40% group. The cross-sectional design allowed assessment of associations at the time of evaluation but did not permit conclusions regarding temporal or causal relationships. In addition, the analyses were mainly unadjusted, and potential confounding factors could not be fully assessed. Further studies with larger samples may provide a more comprehensive assessment of factors related to NT-proBNP concentrations in patients with heart failure.

CONCLUSION

In patients with heart failure, higher NT-proBNP levels were observed in those with valvular heart disease and reduced eGFR. NT-proBNP was weakly correlated with serum creatinine and eGFR, whereas no significant correlation was observed with LVEF. These findings support the consideration of renal function when interpreting NT-proBNP levels in patients with heart failure. Further studies with larger sample sizes and multivariable analyses are warranted to better characterize these relationships.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Generative AI and AI-Assisted Technologies

The authors declare that no artificial intelligence (AI) was used during the research process or in the writing of this manuscript

Author Contributions

La Quoc Khoi Nguyen:conceptualization and study design, performing experiments, data analysis. Ho Huyen Linh: interpretation of results, preparing figures, drafting the manuscript. Le Thi Nhan Duyen: editing and critical review of the manuscript. Nguyen Huu Chuong: final approval of the manuscript.

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