Original Article

Assessing the Correlation Between BNP Levels and Heart Failure Severity: Implications for Clinical Practice

Dr. Bhaimangesh Bhanudas Naik[1], Dr. Mohammad Awais Farooqui[2], Dr. Sandeep Rai[3], Dr. Ratan Rathod[4]
[1]Senior Resident, Department of Cardiology, MGM Medical College and Hospital, Kamothe Navi Mumbai., Maharashtra, India.
[2]MBBS MD Medicine, D.M Cardiology, MGM Medical College and Hospital, Kamothe Navi Mumbai, Maharashtra, India.
[3]Professor Department of General Medicine, MGM Medical College and Hospital, Kamothe Navi Mumbai, Maharashtra, India.
[4]HOD, Department of Cardiology, MGM Medical College and Hospital, Kamothe Navi Mumbai, Maharashtra, India.
***Corresponding author's E-mail:** beintouch58@gmail.com

Received: 22-10-2024; **Revised:** 29-01-2025; **Accepted:** 08-02-2025; **Published online:** 20-02-2025.

ABSTRACT

Background: Heart failure (HF) is a leading cause of morbidity and mortality worldwide, characterized by the heart's inability to pump blood effectively. Accurate diagnosis and management of HF are crucial for improving patient outcomes. B-type natriuretic peptide (BNP) is a biomarker released by the heart in response to increased ventricular wall stress and has been shown to be valuable in the diagnosis, prognosis, and management of heart failure. This study investigates the role of BNP levels in assessing the clinical profile of heart failure patients.

Objectives: The primary aim of this study is to explore the correlation between BNP levels and clinical characteristics such as heart failure severity, symptoms, comorbidities, and prognosis. Specific objectives include evaluating the relationship between BNP levels and the New York Heart Association (NYHA) functional class, left ventricular ejection fraction (LVEF), and common comorbid conditions. Additionally, the study seeks to assess the prognostic value of BNP levels in predicting hospital readmissions, disease progression, and mortality.

Methods: This is a cross-sectional observational study involving adult patients diagnosed with heart failure, recruited from a hospital setting. BNP levels will be measured using standard immunoassay techniques. Clinical data, including NYHA class, LVEF, comorbidities, and clinical symptoms, will be collected through patient records and clinical assessments. Statistical analyses will be conducted to evaluate correlations between BNP levels and clinical parameters, as well as their predictive value for patient outcomes.

Results: It is anticipated that elevated BNP levels will correlate with greater disease severity, as indicated by higher NYHA class, reduced LVEF, and more pronounced symptoms of heart failure. Furthermore, BNP levels are expected to have a significant relationship with comorbidities such as hypertension, diabetes, and renal dysfunction. The study will also assess the prognostic value of BNP levels in predicting hospital admissions, adverse events, and long-term survival.

Conclusion: This study will provide valuable insights into the utility of BNP levels as a biomarker for assessing the clinical profile of heart failure patients. By correlating BNP with clinical severity, symptoms, and prognosis, the findings may help refine diagnostic and therapeutic strategies for heart failure, ultimately improving patient management and outcomes.

Keywords: Heart failure, B-type natriuretic peptide, BNP levels, disease severity, prognosis, clinical profile, biomarkers.

INTRODUCTION

Heart failure (HF) is a complex clinical syndrome characterized by the heart's inability to pump sufficient blood to meet the body's metabolic demands. It is a major public health concern, with increasing prevalence and high morbidity and mortality rates worldwide. The burden of heart failure is expected to grow due to the aging population and improved survival rates of patients with coronary artery disease and hypertension, both significant risk factors for heart failure development [1.] The diagnosis of heart failure is primarily clinical, supported by echocardiographic findings and biomarker measurements. Among the various biomarkers, B-type natriuretic peptide (BNP) has emerged as a key marker for assessing heart failure severity, diagnosis, and prognosis. BNP is a neurohormonal peptide secreted by the heart in response to increased ventricular wall stress, commonly associated with fluid overload in heart failure [2]. Elevated BNP levels have been shown to correlate with heart failure symptoms and severity, serving both diagnostic and prognostic roles [3].

BNP levels can provide valuable insight into the clinical profile of heart failure patients, helping to distinguish heart failure from other conditions with similar symptoms, such as lung diseases and renal failure. Additionally, BNP levels are used to guide treatment decisions, particularly in managing fluid status, and they may help predict the patient's risk for adverse events such as hospital readmission or mortality [4.]

Understanding the relationship between BNP levels and the clinical characteristics of heart failure patients can aid in refining management strategies and improving patient outcomes. This study aims to explore the role of BNP levels in assessing the clinical profile of heart failure patients, focusing on how these levels correlate with clinical manifestations, disease severity, and prognosis.

MATERIALS AND METHODS

This observational, single centred, cross-sectional study was conducted in the Department of Medicine, MGM medical college, Navi Mumbai. Prior approval of ethics committee was taken before the start of study. A written informed consent was taken from all patients prior to their enrolment in the study.

STUDY DESIGN: A cross-sectional hospital based observational study

STUDY SITE: Department of Medicine and Cardiology MGM Medical College, Kamothe, Navi Mumbai

SAMPLING SIZE: 110 consecutive adults diagnosed with heart failure as per the Framingham criteria

SAMPLE SIZE:

The Mean BNP level in HFrEF =899.9 ±1766.4

The Mean BNP level in HFpEF = 302.6 ± 244.0

Formula used for sample size calculation was:

n = (Zα/2+Zβ)2 *2*σ2 / d2

Where, Zα/2 is the critical value of the Normal distribution at α/2 = 1.96

Zβ is the critical value of the Normal distribution at β = 0.84

σ2 is the population variance, and

d is the difference you would like to detect

Putting above values in formula,

n = (1.96+0.84)2 *2*1766.42 / 597.32 = 109

Rounded to 110.

Sample size = 110

STUDY DURATION: June 2021 to December 2022

CONSENT: Informed written consent was taken from all patients who were included in the study

METHODOLOGY

Patients presenting in Department of Medicine in the Medical OPD or the Emergency ward or Cardiology ward with signs and symptoms of heart failure were screened for this study and those fulfilling the Inclusion and exclusion criteria were enrolled in the study after obtaining the informed signed consent.

Consecutive patients of heart failure were selected after ascerting that they met inclusion and exclusion criteria.

General and systemic examinations were carried out.

Left ventricular ejection fraction (LVEF) was measured by 2D ECHO. Patients were

Grouped those having LVEF <40% (HFrEF) and those having LVEF > 50% (HFpEF).

Laboratory investigations were carried out as follows:

CBC, serum urea, serum creatinine, serum sodium, serum potassium, HbA1c, serum Brain natriuretic peptide patients details were entered in semi-structured performas which included socio demographic details, clinical history of patients, general and systemic examination, 2d echo findings and investigations.

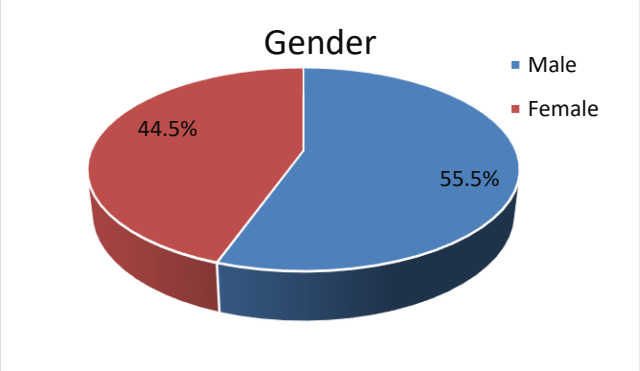
Further follow of patients in regard to their clinical outcome were done on regular interval.

Records were collected for 110 patients and then analysed statistically through SPSS

Table 1: Distribution of patients according to Gender

Gender	N	%
Male	61	55.5%
Female	49	44.5%
Total	110	100%

- 61 (55.5%) patients in study group were male and 49 (44.5%) were female patients.



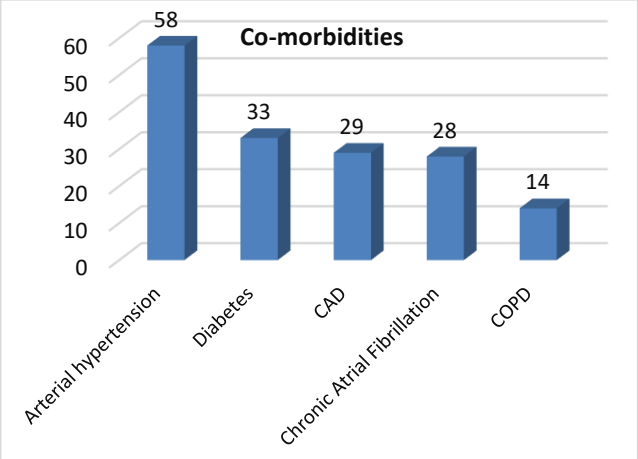
Graph 1: Distribution of patients according to Gender

Table 2: Distribution of patients according to Co-morbidities

Co-morbidities	N	%
Arterial hypertension	58	52.7%
Diabetes	33	30%
CAD	29	26.4%
Chronic Atrial Fibrillation	28	25.4%
COPD	14	12.7%

CAD - Coronary Artery Disease; AF (ACO) - Atrial Fibrillation in Anticoagulation; COPD - Chronic Obstructive Pulmonary Disease

- 58 (52.7%) patients had arterial hypertension, 33 (30%) patients had diabetes, 29 (26.4%) patients had CAD, 28(25.4%) patients had chronic atrial fibrillation, 14 (12.7%) had COPD

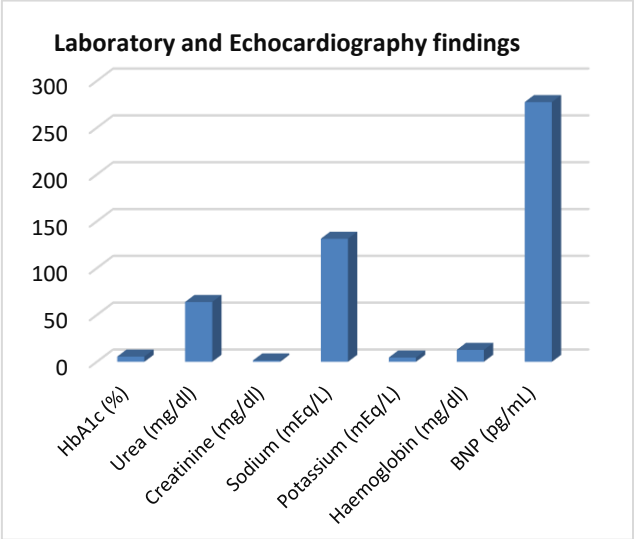


Graph 2: Distribution of patients according to Co-morbidities

Table 3: Laboratory findings of patients of heart failure

Parameters	Mean	SD
HbA1c (%)	5.52	0.82
Urea (mg/dl)	63.88	17.79
Creatinine (mg/dl)	1.47	0.29
Sodium (mEq/L)	131.41	20.40
Potassium (mEq/L)	4.56	0.65
Haemoglobin (mg/dl)	12.74	2.88
BNP (pg/mL)	277.36	173.30

The mean HbA1c and urea values were 5.52±0.82% and 63.88±17.79mg/dl respectively while the mean creatinine and sodium values were 1.47±0.29mg/dl and 131.41±20.40mEq/L respectively. The mean potassium and haemoglobin values were 4.56±0.65mEq/L and 12.74±2.88mg/dl while the mean BNP value of patients was 277.36±173.30pg/mL.

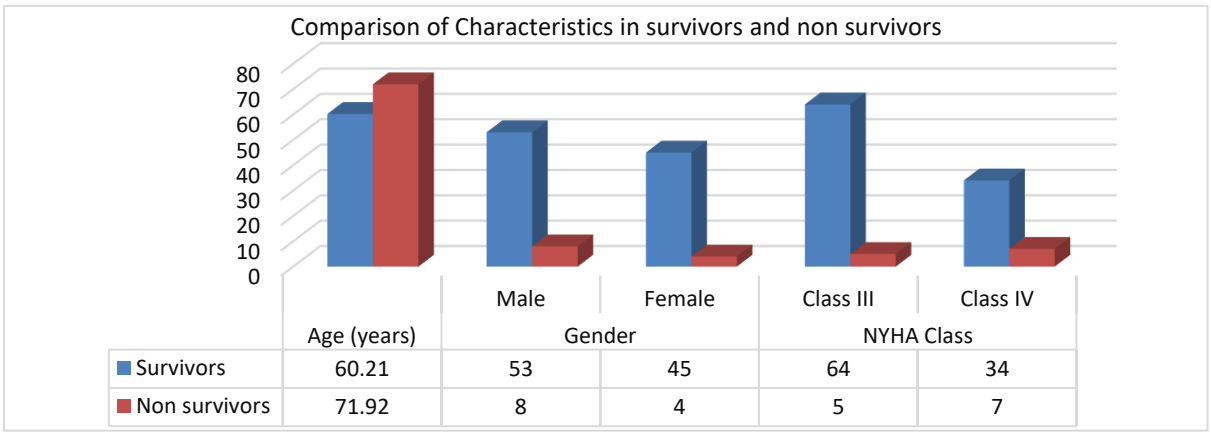


Graph 3: Laboratory findings of patients

Table 4: Comparison of Characteristics in patients with respect to outcomes

Parameters	Survivors (n=98) (Discharged)		Non survivors (n=12)		p Value
	N	%	N	%	
Age (years)	60.21 ± 13.89		71.92 ± 8.76		<0.05
Gender					
Male	53	54.1%	8	66.7%	>0.05
Female	45	45.9%	4	33.3%	
NYHA Class					
Class III	64	65.3%	5	41.7%	<0.05
Class IV	34	34.7%	7	58.3%	

The survivors were significantly younger compared to patients who could not survive (60.21±13.89 years vs. 71.92±8.76 years; **p<0.05**) while there was no significant difference in gender. Significantly higher number of patients who died were in NYHA Class IV (34.7% vs 58.3%; **p<0.05)**

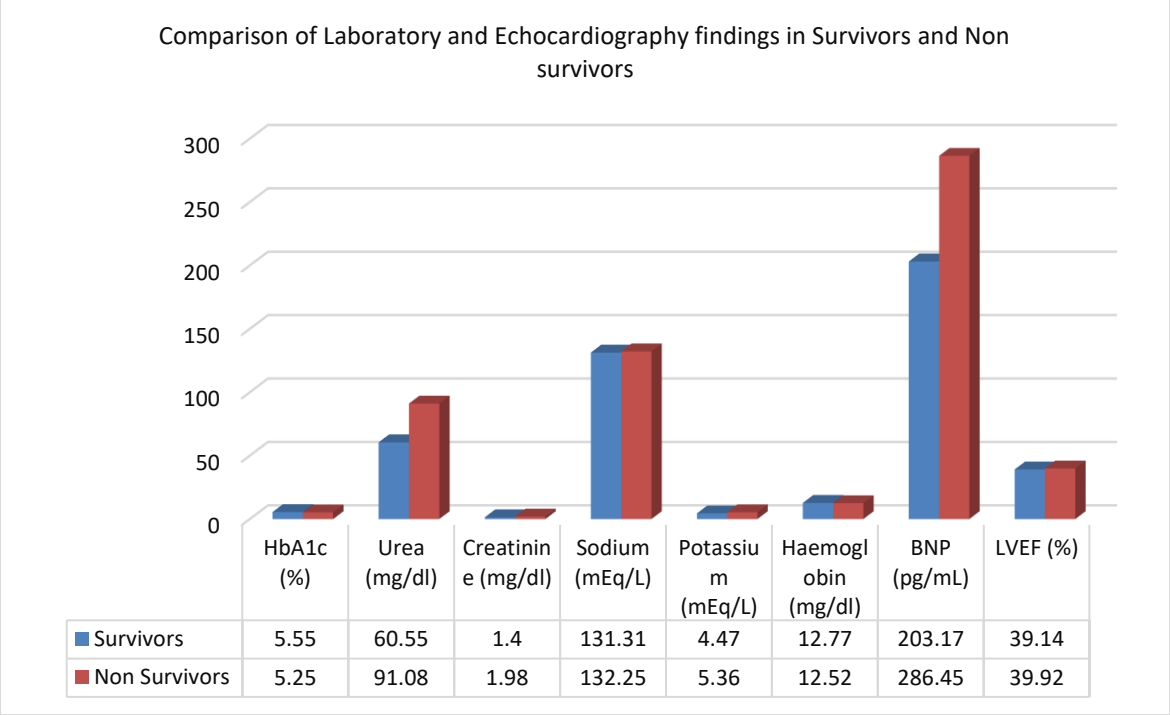


Graph 4: Comparison of Characteristics in patients with respect to outcomes

Table 5: Comparison of Laboratory and Echocardiography findings with outcome of patients

Laboratory and Echocardiography findings	Survivors (n=98)		Non survivors (n=12)		p Value
	Mean	SD	Mean	SD	
HbA1c (%)	5.55 ± 0.79		5.25 ± 0.97		>0.05
Urea (mg/dl)	60.55 ± 14.78		91.08 ± 17.51		**<0.05**
Creatinine (mg/dl)	1.40 ± 0.22		1.98 ± 0.24		**<0.05**
Sodium (mEq/L)	131.31 ± 20.67		132.25 ± 18.86		>0.05
Potassium (mEq/L)	4.47 ± 0.58		5.36 ± 0.63		**<0.05**
Haemoglobin (mg/dl)	12.77 ± 2.98		12.52 ± 1.86		>0.05
BNP (pg/mL)	203.17 ± 155.44		286.45 ± 173.90		**<0.05**
LVEF (%)	39.14 ± 16.07		39.92 ± 19.56		>0.05

In comparison with survivors, the patients who did not survive showed significantly higher levels of urea (60.55±14.78mg/dl vs. 91.08±17.51 mg/dl; **p<0.05**), creatinine (1.40±0.22mg/dl vs. 1.98±0.24mg/dl; **p<0.05**), potassium (4.47±0.58mEq/L vs. 5.36±0.63mEq/L; **p<0.05**) and BNP (203.17±155.44pg/mL vs. 286.45±173.90pg/mL; **p<0.05**). There was no significant difference in levels of HbA1c (5.55±0.79% vs. 5.25±0.97%), sodium (1.31.31±20.67mEq/L vs. 132.25±18.86mEq/L), haemoglobin (12.77±2.98mg/dl vs. 12.52±1.86mg/dl) and LVEF values (39.14±16.07% vs. 39.92±19.56%).

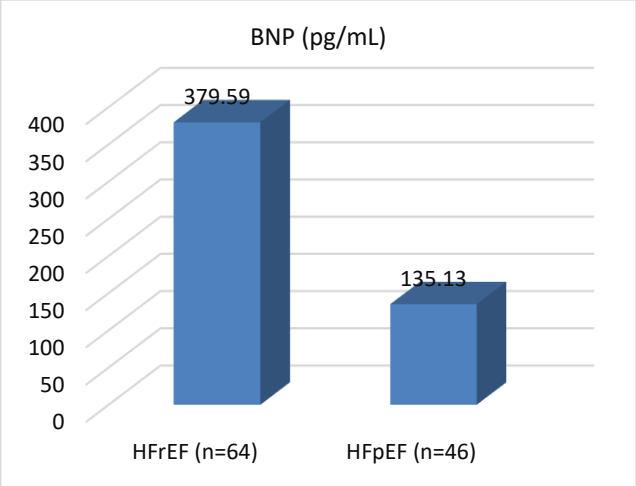


Graph 5: Comparison of Laboratory and Echocardiography findings with outcome of patients

Table 6: Comparison of BNP levels in HFrEF and HFpEF patients

	HFrEF (n=64)		HFpEF (n=46)		p Value
	Mean	SD	Mean	SD	
BNP (pg/mL)	379.59 ± 156.91		135.13 ± 52.27		**<0.05**

The BNP levels in patients with HFrEF patients were significantly higher compared to HFpEF patients (379.59 ± 156.91pg/mL vs. 135.13 ± 52.27pg/mL; **p<0.05**).



Graph 6: Comparison of BNP levels in HFrEF and HFpEF patients

RESULT

- There was a male preponderance (55.5%) amongst study population as compared to female (44.5%).
- Mean laboratory findings of the patients were as follow HbA_1C 5.5%, Urea 63mg/dl, Creatinine 1.47 mg/dl, Sodium 131.41 mEq/L, Potassium 4.56 mEq/L, Hemoglobin 12.74 mg/dl, BNP 277.36 pg/ml.
- Heart failure with reduced ejection fraction (58.2%) were more in number as compared to Heart failure with preserved ejection fraction (41.8%) in the study population.
- Higher levels of urea, creatinine, potassium and BNP was seen in the patients who had mortality as compared to the discharged patients, difference was statistically significant <0.05.
- Complications were seen more in patients who could not survive as compared to the discharged patients, difference was statistically significant <0.05.
- BNP levels were raised in group of HFrEF as compared to HFpEF with statistical significance of P <0.05.

DISCUSSION

The objective of present study was to study the clinical profile of the patients with heart failure. Further, in the present study detailed analysis of demographic parameters and the comorbidities associated with the heart failure were studied. The BNP levels and various risk factors for development of heart failure were also seen in this study.

Our study reports that that out of 110 study subjects, around 56% were male and 44% were females. The proportion of male patients was slightly higher than the female patients. Several studies reported the similar findings that the male gender was dominant among the heart failure patients.[5]

Our study suggested that the among heart failure study subjects, the most common associated co-morbidity was Hypertension. The prevalence of hypertension as a heart failure etiology differs geographically. In a study conducted by Tromp Jet al 36.7% of the heart failure patients had hypertensive heart failure.[6]. A meta-analysis conducted by Tocci G et al[7], showed that around 28.9% of the patients had Hypertension as the most common comorbidity causing Heart Failure[8].

The findings of the current study indicates that the among the 110 heart failure patients included in the study, 26.4% had CAD, 25.4% had Chronic Atrial Fibrillation, and 12.7% had COPD. A systematic review by Khan MS et al. found more than 80% heart failure patients had diabetes, around 30% heart failure patients had hypertension, nearly 80% had CAD, 32% had chronic kidney disease, and 29% had COPD.[9]. The results of our study indicated that 58.2% heart failure patients had reduced ejection fraction (HFrEF) (EF<50%) and 41.8 % had Preserved Ejection Fraction (HFpEF) (EF ≥50%). Similar results were also observed in a study conducted by Solani Y et al in which the results showed that 57% of heart failure patients had reduced ejection fraction (HFrEF) (EF<40%) and 43 % had Preserved Ejection Fraction (HFpEF) (EF ≥50%). These findings are similar to the findings of our study. Among discharged patients, the mean age was 60.21 ± 13.89 and among patients who died, the mean age was 71.92 ± 8.76. The difference in the mean age was statistically significant indicating that the mortality is higher in older age groups as compared to the younger age groups. Krittayaphong et al also reported similar findings where the mean age of patients with mortality due to HF was 76.2±6.8[10]. The proportion of males among mortality in our study was 66.7% and the proportion of females was 33.3%. similar proportion of mortality among males and females was reported in a study by Krittayaphong et al, where the mortality among males was 63.0% and among females it was 37.7%. According to the NYHA class, higher mortality among class IV patients was observed as compared to class III. Levy D et al also reported Similar findings[11]. The laboratory findings were compared among survivors and non survivors. Raised levels of Urea (mg/dl), Creatinine (mg/dl), Sodium (mEq/L), Potassium (mEq/L), BNP (pg/mL) were noted in non survivors whereas the Haemoglobin (mg/dl) level was decreased among the patients who could not survive. These findings are in accordance with the findings of other studies by Otsuka T et al, Khan, M. et al and Matta A et al.[12, 9,13]. The BNP level among patients with HFrEF was higher compared to the HFpEF. The mean BNP (pg/ml) HFrEF subjects was 379.59 ± and HFpEF subjects was 135 ± 52.27. The mean BNP (pg/ml) level among HFrEF was significantly higher as compared to the mean BNP (pg/ml) level among HFrEF. Similar findings were reported in several studies. Maisel et al. concluded HFrEF patients who present with acute decompensated heart failure had the BNP levels, generally between 600–1000 pg/ml[14].

CONCLUSIONS

This study provides significant insights into the demographic, clinical, and laboratory characteristics of

patients with heart failure. The findings highlight several key factors that influence patient outcomes:

1. **Age and Gender Distribution**: The majority of the study population was aged between 61-70 years, with a higher proportion of males. This suggests that heart failure predominantly affects older individuals, with a slight male preponderance.
2. **Clinical Presentation and Co-morbidities**: Most patients had NYHA Class III symptoms, with arterial hypertension being the most common co-morbidity. Diabetes, coronary artery disease, chronic atrial fibrillation, and COPD were also frequently
3. observed, emphasizing the importance of managing these comorbid conditions in heart failure patients.
4. **Risk Factors and Heart Failure Subtypes**: Ischemic heart disease was the most common risk factor for heart failure, and heart failure with reduced ejection fraction (HFrEF) was more prevalent than preserved ejection fraction (HFpEF). This aligns with the higher mortality risk often associated with HFrEF.
5. **Complications and Mortality**: Respiratory tract infections and atrial fibrillation were the most common complications. Despite the relatively high survival rate (89.1%), mortality was notably higher among patients with severe symptoms (NYHA Class IV), those with comorbid coronary artery disease, and those exhibiting higher laboratory values for urea, creatinine, potassium, and BNP.
6. **Factors Influencing Mortality**: Younger patients had a higher survival rate, while those with more severe heart failure (NYHA Class IV) had a higher mortality rate. Additionally, complications were more prevalent in patients who did not survive, indicating that early management of complications could improve outcomes. Higher BNP levels were seen in patients with HFrEF compared to those with HFpEF, further underscoring the severity of this subtype.
7. **Implications for Clinical Practice**: The findings stress the importance of early diagnosis, aggressive management of risk factors such as ischemic heart disease and hypertension, and careful monitoring of laboratory markers (e.g., BNP, creatinine, urea). Additionally, addressing complications promptly may reduce the risk of mortality.

In conclusion, this study underscores the complex interplay of age, comorbidities, heart failure subtypes, and laboratory markers in determining patient outcomes. It also highlights the need for tailored management strategies to improve survival and reduce complications in heart failure patients, particularly those with severe disease or multiple risk factors.

Source of Support: The author(s) received no financial support for the research, authorship, and/or publication of this article

Conflict of Interest: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

1. O'Conner CM, Mudd JO. Heart failure: Current and future therapies. *JAMA*. 2022;328(5):472-484.
2. Mueller C, McDonald K, McMurray J. B-type natriuretic peptide in heart failure: A review of its diagnostic, prognostic, and therapeutic value. *Eur Heart J*. 2005;26(5): 451-457.
3. Januzzi JL, Camargo CA, Anwaruddin S, et al. The N-terminal pro B-type natriuretic peptide (BNP) assay in the evaluation of acute dyspnea. *N Engl J Med*. 2005;352(6): 532-543.
4. McMurray JJV, Pfeffer MA. Heart failure with preserved ejection fraction: A review of pathophysiology and management. *JAMA*. 2016;316(12): 1255-1265.
5. Ali L, Nazeer M, Ahmed I, Fatima M, Niaz N. Factors precipitating acute heart failure.
6. Tromp J, Cleland JGF, Borer J, et al. Heart failure with preserved ejection fraction in Asia. Eur J Heart Fail. 2019 Jan;21(1):23-36. doi: 10.1002/ejhf.1227.
7. Rørth R, Docherty KF, Jhund PS, et al. Comparison of BNP and NT-proBNP in patients with heart failure and reduced ejection fraction. Circ Heart Fail. 2020 Feb;13(2):e006541. doi: 10.1161/CIRCHEARTFAILURE.119.006541.
8. Tocci G, Sciarretta S, Volpe M. Development of heart failure in recent hypertension trials. J Hypertens. 2008 Jul;26(7):1477-86. doi: 10.1097/HJH.0b013e3282fe1d3d.
9. Khan MS, Sritara P, Khan H, et al. Trends in prevalence of comorbidities in heart failure clinical trials. Eur J Heart Fail. 2020 Jun;22(6):1032-42. doi: 10.1002/ejhf.1818.
10. Krittayaphong R, Karaketklang K, Yindeengam A, Janwanishstaporn S. Heart failure mortality compared between elderly and non-elderly Thai patients. J Geriatr Cardiol. 2018 Dec;15(12):718-24. doi: 10.11909/j.issn.1671-5411.2018.12.006
11. Levy D, Larson MG, Vasan RS, Kannel WB, Ho KK. The progression from hypertension to congestive heart failure. JAMA. 1996 May;275(20):1557-62.
12. Otsuka T, Yamashita T, Takagi A, et al. Dyslipidemia and the risk of developing hypertension in a working-age male population. J Am Heart Assoc. 2016 Mar;5(3):e003053. doi: 10.1161/JAHA.115.003053.
13. Djer MM, Osmardin E, Hegar B, Setyanto DB. Increased risk of recurrent acute respiratory infections in children with congenital heart disease: A prospective cohort study. Indones Biomed J. 2020 Dec;12(4):355-60. doi: 10.18585/inabj.v12i4.1262.
14. Maisel AS, Krishnaswamy P, Nowak RM, et al. Bedside B-type natriuretic peptide in the emergency diagnosis of heart failure with reduced or preserved ejection fraction. Results from the Breathing Not Properly Multinational Study. J Am Coll Cardiol. 2003 Jun;41(11):2010-7. doi: 10.1016/s0735-1097(03)00405-4.