

Original Research Article

ASSOCIATION OF ADMISSION NT-PROBNP WITH IN-HOSPITAL MORTALITY IN ICU-ADMITTED HEART FAILURE PATIENTS: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Heart failure (HF) is a major cause of morbidity and mortality among patients requiring intensive care. Reliable biomarkers that can assist early risk stratification are particularly useful in resource-limited tertiary care settings. The objective is to evaluate the association of admission N-terminal pro-B-type natriuretic peptide (NT-proBNP), haemoglobin (Hb), and red cell distribution width (RDW) with in-hospital mortality and hospital stay, and to assess their relationship with ejection fraction.

Materials and Methods: This hospital-based observational cross-sectional study included 80 consecutive adults admitted to the ICU with HFrEF or HFmrEF. Admission Hb, RDW, ejection fraction (EF), and serum NT-proBNP were recorded. Outcomes were compared between survivors and non-survivors using independent-samples t-tests and chi-square tests. Point-biserial/Pearson correlation was used for continuous variables against the binary outcome of death, and exploratory receiver-operating-characteristic (ROC) analysis was performed.

Results: Mean age was 52.6 ± 11.9 years and 72.5% of participants were male. In-hospital mortality was 38.8% (31/80). Mean NT-proBNP was higher in non-survivors than survivors (5239.4 ± 2568.4 vs 3127.8 ± 2118.5 pg/mL; $t=3.83$, $p=0.0003$). Mortality was higher among patients with NT-proBNP >5000 pg/mL than among those with NT-proBNP ≤ 5000 pg/mL (56.7% vs 28.0%; $\chi^2=5.34$, $p=0.021$). Mean EF was lower in non-survivors ($31.9 \pm 5.4\%$ vs $36.9 \pm 5.6\%$; $t=3.91$, $p=0.0002$), and mortality was higher in HFrEF than HFmrEF (51.9% vs 14.3%; $\chi^2=9.34$, $p=0.0022$). Hb and RDW did not differ significantly between groups ($p=0.585$ and $p=0.853$, respectively).

Conclusion: Higher admission NT-proBNP and lower ejection fraction were significantly associated with in-hospital mortality in this ICU cohort. Hb and RDW were not significantly associated with mortality. NT-proBNP may be useful as an adjunct to early risk stratification, although prospective multicentre studies are required to validate its prognostic performance.

Keywords: Heart failure, NT-proBNP, in-hospital mortality, intensive care unit, ejection fraction, red cell distribution width, prognosis.

INTRODUCTION

Heart failure (HF) is a complex clinical syndrome and a major global public health concern, affecting more than 64 million people worldwide. Its burden continues to rise with population ageing and

improved survival from cardiovascular disease. Risk stratification at ICU admission is important for determining monitoring intensity, treatment decisions, and communication with patients and families. Natriuretic peptides, particularly NT-proBNP, are released in response to myocardial wall

stress and are established diagnostic and prognostic biomarkers in HF. Elevated concentrations have been associated with adverse outcomes, including mortality, in chronic and acutely decompensated HF.^[1-3]

In addition to natriuretic peptides, inexpensive haematological parameters such as haemoglobin (Hb) and red cell distribution width (RDW) have been evaluated as adjunct prognostic markers. RDW, a measure of erythrocyte size variability, has been associated with adverse outcomes in HF and has been investigated in the CHARM Program, Duke Databank, and subsequent HF cohorts.^[4-6,8]

NT-proBNP concentrations can also be elevated in critically ill patients and have been associated with illness severity and mortality.^[7]

However, data evaluating NT-proBNP together with Hb and RDW specifically among ICU-admitted HF patients in Indian tertiary-care settings remain limited.

The present study therefore examined the association of admission NT-proBNP, Hb and RDW with in-hospital mortality and hospital stay, and their relationship with ejection fraction.

Objectives

1. To determine admission levels of NT-proBNP, Hb and RDW among ICU-admitted heart failure patients.
2. To assess the association of these parameters with in-hospital mortality, duration of hospital stay, and ejection fraction.
3. To assess the discriminatory performance of admission NT-proBNP and ejection fraction for in-hospital mortality using exploratory ROC analysis.

MATERIALS AND METHODS

Study Design and Setting: A hospital-based, observational cross-sectional study was conducted in the Department of General Medicine/Intensive Care Unit of Basaveshwar Medical College and Hospital, Chitradurga, Karnataka, India, a tertiary-care teaching hospital, over a period of one year [insert exact study dates].

Study population

Eighty consecutive adults admitted to the ICU with a clinical diagnosis of heart failure and echocardiographically documented HFrEF or HFmrEF were enrolled after informed consent. Patients were selected consecutively from eligible ICU admissions during the study period. Heart failure was classified according to the Universal Definition and Classification of Heart Failure.^[2]

Inclusion Criteria

Adults aged >18 years admitted to the ICU with HFrEF (EF <40%) or HFmrEF (EF 40–49%) confirmed by echocardiography.

Study size: The study included 80 consecutive eligible patients during the one-year study period; no separate a priori sample-size calculation is documented in the supplied study material.

Exclusion Criteria

Chronic kidney disease on dialysis, known haematological disorders, pregnancy, and refusal to provide consent.

Data Collection

At admission, demographic data, complete blood count (including Hb and RDW), renal function tests, two-dimensional echocardiographic ejection fraction, and serum NT-proBNP were recorded on a structured proforma. Patients were followed until hospital discharge or death. Final in-hospital outcome and duration of hospital stay were documented.

Statistical analysis

Data were entered in Microsoft Excel and analysed using SPSS (version 25 or later). Continuous variables are presented as mean $\pm$ standard deviation and were compared between survivors and non-survivors using independent-samples t-tests. Categorical variables were compared using the chi-square test. The binary outcome of in-hospital death was coded for correlation analysis; Pearson correlation with a binary outcome is equivalent to a point-biserial correlation. Exploratory ROC analysis was used to estimate the area under the curve (AUC) for NT-proBNP and ejection fraction. A two-tailed p-value <0.05 was considered statistically significant. Missing-data handling was not performed as a separate analysis.

Ethical considerations

The study was conducted after approval from the Institutional Ethics Committee of Basaveshwar Medical College and Hospital, Chitradurga (approval number: [insert actual IEC approval number]). Written informed consent was obtained from all participants or their legally authorised representatives.

RESULTS

A total of 80 ICU-admitted patients with heart failure were included and analysed. Mean age was 52.6 ± 11.9 years; 58 (72.5%) were male and 22 (27.5%) were female. Overall in-hospital mortality was 31/80 (38.8%), while 49 (61.2%) patients were discharged alive. No participant-flow diagram was available in the supplied study material.

Table 1: Baseline characteristics of the study population (n=80)

Parameter	Value
Mean age (years)	52.6 $\pm$ 11.9
Male : Female	58 (72.5%) : 22 (27.5%)
Mean ejection fraction (%)	34.9 $\pm$ 6.8
HFrEF (EF<40%)	52 (65.0%)
HFmrEF (EF 40–49%)	28 (35.0%)

Mean hospital stay (days)	9.6 ± 6.9 (median 10)
In-hospital mortality	31 (38.8%)

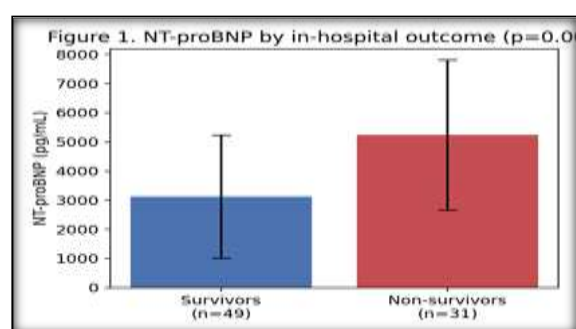
Table 2: Comparison of parameters between survivors and non-survivors

Parameter	Survivors (n=49)	Non-survivors (n=31)	t	p-value
NT-proBNP (pg/mL)	3127.8 ± 2118.5	5239.4 ± 2568.4	3.83	0.0003*
Ejection fraction (%)	36.9 ± 5.6	31.9 ± 5.4	3.91	0.0002*
Hospital stay (days)	11.7 ± 5.9	6.1 ± 7.7	3.46	0.0011*
Haemoglobin (g/dL)	8.69 ± 1.68	8.90 ± 1.63	0.55	0.585
RDW (%)	15.06 ± 2.33	15.16 ± 2.16	0.19	0.853

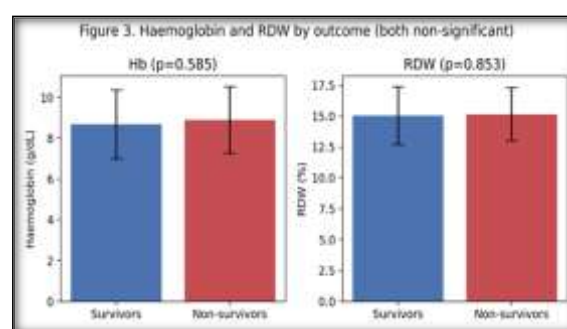
*p<0.05; independent-samples t-test, two-tailed.

Table 3: Mortality by categorical risk groups

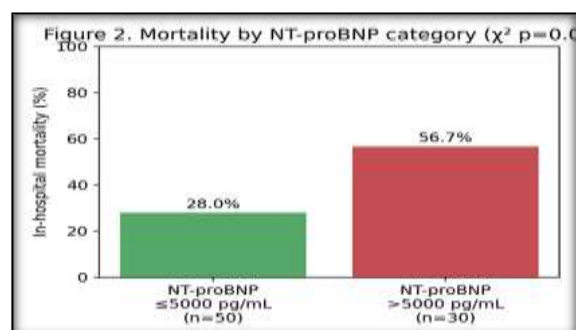
Group	n	Deaths (%)	χ^2	p-value
NT-proBNP >5000 pg/mL	30	17 (56.7%)	5.34	0.021*
NT-proBNP ≤5000 pg/mL	50	14 (28.0%)	—	—
HFrEF (EF<40%)	52	27 (51.9%)	9.34	0.0022*
HFmrEF (EF 40–49%)	28	4 (14.3%)	—	—
Anaemia (Hb<10 g/dL)	48	19 (39.6%)	0.00	1.000
Non-anaemic (Hb≥10 g/dL)	32	12 (37.5%)	—	—



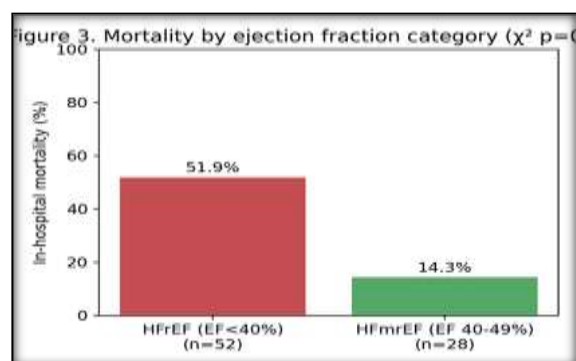
[Figure 1] Mean admission NT-proBNP (±SD) among survivors and non-survivors



[Figure 4. Mean haemoglobin and RDW according to in-hospital outcome; neither difference was statistically significant



[Figure 2] In-hospital mortality according to the exploratory NT-proBNP category



[Figure 3] In-hospital mortality according to ejection fraction category

In point-biserial/Pearson correlation analysis, admission NT-proBNP showed a positive correlation with in-hospital mortality ($r=0.41$, $p=0.0001$). NT-proBNP showed negative correlations with ejection fraction ($r=-0.19$) and hospital stay ($r=-0.16$); p-values for these two correlations were not reported in the source dataset. Hb ($r=0.06$, $p=0.587$) and RDW ($r=0.02$, $p=0.856$) showed weak, non-significant correlations with mortality. Exploratory ROC analysis yielded an AUC of 0.75 for NT-proBNP and 0.75 for ejection fraction. Confidence intervals were not reported. All analyses were unadjusted; no multivariable model was performed.

DISCUSSION

In this cross-sectional study of 80 ICU-admitted patients with heart failure, in-hospital mortality was 38.8%. The principal finding was a significant association between higher admission NT-proBNP and in-hospital mortality. Patients who died had substantially higher mean NT-proBNP concentrations than survivors, and mortality was also higher in the exploratory group with NT-proBNP >5000 pg/mL. These findings are consistent with the established association between natriuretic peptide

elevation and disease severity and adverse outcomes in HF.^[1,3,7]

The higher mortality observed with greater NT-proBNP concentrations is biologically plausible because NT-proBNP reflects myocardial wall stress and haemodynamic burden. Studies in critically ill populations have also reported associations between NT-proBNP concentrations and mortality, supporting its potential role as a marker of overall illness severity.^[7] However, NT-proBNP should be interpreted in the clinical context because concentrations may be influenced by factors such as renal dysfunction and age.

Mortality was also significantly higher among patients with HFrEF than among those with HFmrEF, and mean ejection fraction was lower in non-survivors. This supports the association between greater systolic dysfunction and short-term adverse outcome. In contrast, Hb and RDW were not significantly associated with mortality in the present cohort. This differs from larger HF cohorts in which RDW has demonstrated prognostic associations.^[4-6,8] The discrepancy may relate to the modest sample size, the acutely ill ICU population, and the possibility that acute haemodynamic severity contributes more strongly to short-term outcome than chronic haematological markers. These explanations remain hypotheses and require confirmation in larger studies.

Limitations

This was a single-centre cross-sectional study with a modest sample size, limiting generalisability and preventing causal inference. NT-proBNP and other laboratory parameters were measured only at admission, so the prognostic value of serial changes could not be assessed. Important potential confounders, including renal function, age, HF aetiology, and treatment differences, were not evaluated using multivariable regression. Therefore, the observed associations should not be interpreted as independent predictors. The 5000 pg/mL NT-proBNP threshold was exploratory and was not externally validated. ROC confidence intervals and detailed diagnostic-performance measures were not available in the source dataset. Missing-data handling was not performed as a separate analysis.

CONCLUSION

In this single-centre ICU cohort, higher admission NT-proBNP and lower ejection fraction were significantly associated with in-hospital mortality, whereas Hb and RDW were not. Admission NT-proBNP may be a useful adjunct for early risk stratification in critically ill patients with heart failure. Because this study was cross-sectional, had a modest sample size, and did not include multivariable adjustment or external validation, the findings should be considered hypothesis-generating and confirmed in larger prospective multicentre studies.

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