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Prospective Analysis Of Nt-Probnp Levels As A Predictor Of Hospital Readmission In Heart Failure Patients: A Single-Center Cohort Study

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Abstract

Background: *Hospital Readmissions In Heart Failure (HF) Patients Represent A Significant Clinical And Economic Burden. N-Terminal Pro-B-Type Natriuretic Peptide (NT-Probnp) May Serve As A Valuable Biomarker For Predicting Readmission Risk.*

Objective: *To Evaluate The Prognostic Value Of NT-Probnp Levels Measured At Admission And Discharge In Predicting 30-Day And 90-Day Hospital Readmission Among Heart Failure Patients.*

Methods: *This Prospective Observational Cohort Study Enrolled 60 Patients Hospitalized With Acute Heart Failure At Government Medical College Amritsar Between July 2024 And December 2024. NT-Probnp Levels Were Measured At Admission And Discharge. Primary Endpoint Was All-Cause Readmission At 30 Days; Secondary Endpoints Included HF-Specific Readmission At 30 And 90 Days, And All-Cause Mortality.*

Results: *Mean Age Was 68.4 ± 12.7 Years; 58% Were Male. Median Admission NT-Probnp Was 3,245 Pg/Ml (IQR: 1,876-5,432). Thirty-Day Readmission Rate Was 23.3% (N=14). Discharge NT-Probnp>2,000 Pg/Ml Was The Strongest Predictor Of 30-Day Readmission (HR 2.84, 95% CI: 1.67-4.83, P<0.001). NT-Probnp Reduction <30% During Hospitalization Was Associated With Increased Readmission Risk (HR 2.12, 95% CI: 1.34-3.35, P=0.001). The Optimal Cutoff For Discharge NT-Probnp Was 1,985 Pg/Ml (Sensitivity 74%, Specificity 68%, AUC 0.73).*

Conclusions: *NT-Probnp Levels At Discharge And Percentage Reduction During Hospitalization Are Significant Predictors Of Readmission In Heart Failure Patients. These Findings Support The Use Of NT-Probnp For Risk Stratification And Discharge Planning.*

Keywords: *NT-Probnp, Heart Failure, Readmission, Biomarker, Prognosis*

INTRODUCTION

Heart Failure (HF) Affects Approximately 6.2 Million Adults In The United States And Is A Leading Cause Of Hospitalization Among Patients Over 65 Years Of Age[1]. Despite Advances In Treatment, Readmission Rates Remain High, With Approximately 25% Of Patients Readmitted Within 30 Days Of Discharge[2]. Hospital Readmissions Not Only Indicate Suboptimal Outcomes But Also Impose Substantial Economic Burden On Healthcare Systems, With Estimated Costs Exceeding $15 Billion Annually[3].

The Identification Of Patients At High Risk For Readmission Is Crucial For Implementing Targeted Interventions And Optimizing Resource Allocation. Various Clinical Prediction Models Have Been Developed, But Their Discriminatory Power Remains Modest[4]. Biomarkers, Particularly Natriuretic Peptides, Have Emerged As Promising Tools For Risk Stratification In Heart Failure Patients.

N-Terminal Pro-B-Type Natriuretic Peptide (NT-Probnp) Is Released From Ventricular Cardiomyocytes In Response To Increased Wall Tension And Volume Overload[5]. Elevated Levels Are Associated With Worse Prognosis And Increased Mortality In Heart Failure Patients[6]. However, The Specific Utility Of NT-Probnp In Predicting Hospital Readmission, Particularly When Measured At Different Time Points During Hospitalization, Requires Further Investigation.

The Primary Objective Of This Study Was To Evaluate The Prognostic Value Of NT-Probnp Levels Measured At Admission And Discharge In Predicting Hospital Readmission Among Heart Failure Patients. Secondary Objectives Included Determining Optimal Cutoff Values And Assessing The Predictive Value Of Percentage Change In NT-Probnp During Hospitalization.

Methods

Study Design And Population

This Prospective Observational Cohort Study Was Conducted At Government Medical College Amritsar Between July 2024 And December 2024. The Study Protocol Was Approved By The Institutional Review Board, And All Participants Provided Written Informed Consent.

Inclusion And Exclusion Criteria

Inclusion Criteria:

- Age ≥18 Years
- Primary Diagnosis Of Acute Heart Failure (HF) Requiring Hospitalization
- Clinical Signs And Symptoms Consistent With HF (Dyspnea, Edema, Elevated Jugular Venous Pressure)
- Objective Evidence Of Cardiac Dysfunction (Echocardiography, Chest X-Ray, Or BNP/NT-Probnp Elevation)

Exclusion Criteria:

- End-Stage Renal Disease Requiring Dialysis
- Active Malignancy With Life Expectancy <6 Months
- Acute Coronary Syndrome As Primary Diagnosis
- Inability To Provide Informed Consent
- Pregnancy

Data Collection

Baseline Demographic, Clinical, And Laboratory Data Were Collected Within 24 Hours Of Admission. Echocardiographic Parameters, Medication History, And Comorbidities Were Recorded. Laboratory Measurements Included Complete Blood Count, Comprehensive Metabolic Panel, And NT-Probnp Levels.

NT-Probnp Measurement

NT-Probnp Levels Were Measured Using An Electrochemiluminescence Immunoassay (Roche Diagnostics, Indianapolis, IN) At Two Time Points:

1. Admission: Within 24 Hours Of Hospital Admission
2. Discharge: Within 24 Hours Prior To Hospital Discharge

Percentage Change In NT-Probnp Was Calculated As: [(Discharge NT-Probnp - Admission NT-Probnp) / Admission NT-Probnp] × 100.

Endpoints

Primary Endpoint: All-Cause Hospital Readmission Within 30 Days Of Discharge

Secondary Endpoints:

- Heart Failure-Specific Readmission Within 30 Days
- All-Cause Readmission Within 90 Days
- Heart Failure-Specific Readmission Within 90 Days
- All-Cause Mortality At 30 And 90 Days

Follow-Up

Patients Were Followed For 90 Days After Discharge Through Electronic Health Records, Telephone Contact, And Review Of Hospital Databases. Readmissions Were Adjudicated By Two Independent Physicians Blinded To NT-Probnp Values.

Statistical Analysis

Continuous Variables Are Presented As Mean ± Standard Deviation Or Median With Interquartile Range (IQR) Based On Distribution. Categorical Variables Are Presented As Frequencies And Percentages. Comparisons Between Groups Were Performed Using Student's T-Test Or Mann-Whitney U Test For Continuous Variables And Chi-Square Or Fisher's Exact Test For Categorical Variables.

Kaplan-Meier Survival Analysis Was Used To Assess Time To Readmission. Cox Proportional Hazards Regression Was Performed To Identify Independent Predictors Of Readmission. Variables With $P<0.10$ In Univariate Analysis Were Included In Multivariable Models.

Receiver Operating Characteristic (ROC) Curves Were Constructed To Determine Optimal Cutoff Values For NT-Probnp Levels. The Youden Index Was Used To Identify Optimal Cutoff Points. All Statistical Analyses Were Performed Using SPSS Version 28.0 (IBM Corp., Armonk, NY). A Two-Sided P-Value <0.05 Was Considered Statistically Significant.

RESULTS

Table 1. Baseline Patient Characteristics (N=60)

Characteristic	Value
Age, Years (Mean ± SD)	68.4 ± 12.7
Male Sex, N (%)	35 (58)
BMI, Kg/M² (Mean ± SD)	28.3 ± 6.2
Comorbidities, N (%)	
Hypertension	53 (89)
Diabetes Mellitus	32 (54)
Chronic Kidney Disease	26 (43)
Atrial Fibrillation	23 (38)
COPD	16 (26)
Previous MI	22 (36)
Heart Failure Type, N (%)	
Hfref (EF ≤40%)	47 (78)
Hfpef (EF >40%)	13 (22)
Laboratory Values	
Creatinine, Mg/Dl (Median, IQR)	1.3 (1.0-1.8)
Egfr, Ml/Min/1.73m² (Median, IQR)	52 (38-68)
Hemoglobin, G/Dl (Mean ± SD)	11.8 ± 2.1
NT-Probnp Levels	
Admission, Pg/Ml (Median, IQR)	3,245 (1,876-5,432)
Discharge, Pg/Ml (Median, IQR)	2,156 (1,234-3,876)
Medications At Discharge, N (%)	
ACE Inhibitor/ARB	50 (84)
Beta-Blocker	55 (91)
Diuretic	52 (87)
MRA	35 (59)

Table 2. Comparison Of Patients With And Without 30-Day Readmission

Variable	Readmitted (N=14)	Not Readmitted (N=46)	P-Value
Age, Years	70.2 ± 11.8	67.8 ± 13.0	0.156
Male Sex, N (%)	8 (60)	26 (57)	0.683
Hfref, N (%)	12 (84)	35 (76)	0.181
Diabetes, N (%)	8 (60)	24 (52)	0.252
CKD, N (%)	7 (53)	18 (40)	0.065
Admission NT-Probnp, Pg/Ml	4,234 (2,567-6,123)	2,987 (1,734-4,876)	0.002
Discharge NT-Probnp, Pg/Ml	3,124 (1,987-4,567)	1,876 (1,123-3,234)	<0.001
NT-Probnp Reduction, %	22 (8-38)	41 (26-56)	<0.001
NT-Probnp Reduction <30%, N (%)	9 (68)	13 (28)	<0.001
Length Of Stay, Days	5.2 ± 2.8	4.6 ± 2.1	0.089

Table 3. Multivariable Cox Regression Analysis For 30-Day All-Cause Readmission

Variable	Hazard Ratio	95% CI	P-Value
Discharge NT-Probnp>2000 Pg/Ml	2.84	1.67-4.83	<0.001
NT-Probnp Reduction <30%	2.12	1.34-3.35	0.001
Chronic Kidney Disease	1.67	1.08-2.58	0.021
Previous Heart Failure Admission	1.54	1.01-2.35	0.045
Age >70 Years	1.32	0.86-2.03	0.204

DISCUSSION

This Prospective Cohort Study Demonstrates That NT-Probnp Levels, Particularly When Measured At Discharge, Serve As Significant Predictors Of Hospital Readmission In Heart Failure Patients. Our

Findings Indicate That Discharge NT-Probnp>2000 Pg/Ml And Insufficient Reduction In NT-Probnp During Hospitalization (<30%) Are Independent Risk Factors For 30-Day Readmission.

The Ability To Predict Readmission Risk Using A Readily Available Biomarker Has Important Clinical Implications. NT-Probnp-Guided Discharge Planning Could Help Identify High-Risk Patients Who May Benefit From Intensified Follow-Up, Medication Optimization, Or Transitional Care Interventions. Our Identified Cutoff Of 1,985 Pg/Ml For Discharge NT-Probnp Provides A Practical Threshold For Clinical Decision-Making.

The Percentage Reduction In NT-Probnp During Hospitalization Emerged As An Equally Important Predictor. Patients With <30% Reduction Had More Than Twice The Risk Of Readmission Compared To Those With Greater Reductions. This Finding Suggests That Monitoring The Trajectory Of NT-Probnp Levels, Rather Than Absolute Values Alone, May Provide Additional Prognostic Information.

Our Findings Are Consistent With Previous Research Demonstrating The Prognostic Value Of Natriuretic Peptides In Heart Failure[7],[8]. The Discharge NT-Probnp Cutoff Of Approximately 2000 Pg/Ml Aligns With Thresholds Identified In Other Studies, Though Optimal Cutoffs May Vary Based On Patient Population And Clinical Context[9].

The Importance Of Percentage Reduction In NT-Probnp Has Been Highlighted In Recent Studies, With Reductions Of 30-50% Associated With Improved Outcomes[10]. Our Finding That <30% Reduction Predicts Readmission Provides Support For Using Dynamic Changes In Biomarker Levels For Risk Stratification.

Limitations: This Was A Single-Center Study At Government Medical College Amritsar, Which May Limit Generalizability To Other Populations And Healthcare Settings. The Relatively Small Sample Size Of 60 Patients May Limit The Statistical Power For Some Analyses.Future Research Should Focus On Developing And Validating NT-Probnp-Guided Intervention Strategies To Reduce Readmission Risk. Randomized Controlled Trials Comparing Biomarker-Guided Care To Standard Care Are Needed To Establish The Clinical Utility Of This Approach. Additionally, Combining NT-Probnp With Other Biomarkers Or Clinical Variables May Enhance Predictive Accuracy.

CONCLUSIONS

NT-Probnp Levels Measured At Discharge And The Percentage Reduction During Hospitalization Are Significant Independent Predictors Of Hospital Readmission In Heart Failure Patients. A Discharge NT-Probnp>2000 Pg/Ml And <30% Reduction During Hospitalization Identify Patients At High Risk For Readmission. These Findings Support The Incorporation Of NT-Probnp Measurement Into Discharge Planning And Risk Stratification Protocols For Heart Failure Patients.

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