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AN UPDATED ANALYSIS OF ETIOLOGIES AND PROGNOSIS OF 30-DAY READMISSION IN HEART FAILURE

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ABSTRACT: Background: The prevalence of Heart Failure (HF) is expected to rise over the next few decades, placing a significant strain on the healthcare system. Exact risk stratification in HF is still difficult, even though numerous prognostic markers of death and/or HF hospitalization have been found in HF patients; nonetheless, their practical usefulness is restricted. **Aim and Objective:** The current study aimed to determine the etiology of hospitalization and readmission with HF patients, and the factors associated with readmission. **Materials and Methods:** A prospective-observational study was conducted with 81 HF patients for 3 months. The patient's data collection form and cash sheets were used to record the patient's clinical information's. The collected data were analyzed using the SPSS statistical software. **Results:** A total of 81 patients were included in this study. The study participants' median age was 61.5 years, with the majority being male (70.37%). Dyspnea (80.24%) was the most common symptom. HFrEF(86.41%) was the most prevalent type of HF. Type 2 DM (72.83%) was the most common co-morbid condition. There is an inverse correlation between compliance and readmission with a p-value of 0.007. The class of HF was strongly (p=0.043) correlated with readmission. An increased levels of NT proBNP, Troponin T, and HbA1C%, serum urea level, and blood pressure were observed in readmission. **Conclusion:** The noncompliance, high serum urea, decreased EF, high blood pressure, poorly managed HbA1C, and lack of ACEIs were all significantly associated to HF readmission. The risk of readmission and mortality may be mitigated by focusing on improving medication adherence through patient education and managing co-morbidities.

INTRODUCTION: Worldwide, heart failure (HF) is the primary cause of mortality. Heart and blood vessel problems collectively are known as heart failures. HF comprises peripheral artery disease, rheumatic heart disease, congenital heart disease, coronary heart disease, cerebrovascular illness, deep vein thrombosis, and pulmonary embolism [1].

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In 2019, a projected 56.2 million people were living with HF in 204 countries worldwide, albeit this figure is likely to underestimate the true prevalence of HF due to data and diagnostic gaps in under-developing countries [2].

The World Health Organization (WHO) estimates that 17.9 million fatalities worldwide in 2019 were due to HF, accounting for 32% of all mortality. Heart attacks and strokes were the cause of 85% of these fatalities. The majority of HF fatality more than 75% occurs in low- and middle-income nations. In 2019, noncommunicable illnesses accounted for 17 million premature fatalities (mortality under 70 years old), of which 38% were

attributable to HF [1]. In India, it is estimated that roughly 5.4 million (0.5%) persons were afflicted with HF in 2016. However, this value may be underestimated due to fewer individuals seeking healthcare consultation and insufficient disease identification in India. According to the Indian Medical Registry, the proportionate mortality rate from HF increased from 19% in 1990 to 34% in 2017. International studies assessing the financial impact of HF across various countries indicate that HF accounts for 1-2 percent of overall healthcare spending, with hospitalization accounting for the majority of costs. Over 20–30% of patients with HF who are discharged have to return to the hospital within 30–60 days, indicating a significant rehospitalization rate [3, 4].

Of the population-attributable risks for HF, 52% are related to coronary heart disease (CHD), hypertension, diabetes, obesity, and smoking. The percentages of risks are as follows 20% have CHD, 20% have hypertension, 14% are smokers, 12% are obese, and 12% have diabetes [2].

Recently, the prognosis for HF has improved due to innovative medical and technological therapy. Biventricular pacemakers, remote pulmonary artery pressure monitors, mechanical circulatory assist devices, SGLT2 inhibitors, angiotensin receptor–neprilysin inhibitor combinations, a novel algorithm for guideline-directed medical therapy, and the application of disease management programs in the outpatient setting are a few of these. HF patients still have a significant probability of readmission, which contributes to patient morbidity and heavy use of healthcare resources [5].

The prevalence of HF is expected to rise over the next few decades, placing a significant strain on India's healthcare system. Exact risk stratification in HF is still difficult, even though numerous prognostic markers of death and/or HF hospitalization have been found in HF patients; nonetheless, their practical usefulness is restricted. Treatment optimization and management customization will be possible if patients with HF who are very likely to die or rehospitalize after being discharged from the hospital are identified. Based on this backdrop, the current study aimed to figure out the etiology of hospitalization and readmission in HF patients, and the predictors in HF readmission.

MATERIALS AND METHODS: A single-center prospective-observational study was conducted in the cardiology department of Kovai Medical Center and Hospital, a modernized 850-bed multispecialty hospital in Coimbatore, South India. This study was approved on July 13, 2022, by the institution's ethics committee. The permission number for this study was EC/AP/950/07/2022. The sample size of 81 patients was determined. The HF patients who were included in this study were selected using convenience sampling. The study was conducted for three months. This research was carried out with each participant's approved written informed consent. This study included patients who were admitted for HF treatment, regardless of gender, and who were at least 18 years old. Patients with cognitive disorders, physical inactivity, pregnancy, or age below 18 years were excluded from this study.

Study Methodology: The patient's age, gender, presenting symptoms, co-morbidity, type of heart failure, cardiology profile according to New York Heart Association (NYHA) functional class, prescribed medication, length of hospital stay, reports from radiology, laboratory data included hemoglobin (Hb) level, Red blood cell count, urea level, creatinine level, serum sodium and serum potassium levels, NT-proBNP, and Troponin T levels, and readmission rate were all gathered using the patient's data collection form and case reports. The patient interview was used to assess medical adherence. All the patients were followed up to 30 days. The collected data were analyzed to determine the causes of admission and readmission.

Statistical Analysis: The data was analyzed using SPSS version 28 (SPSS Inc., Chicago, IL). The independent t-test was employed to ascertain the significance of differences between the mean values of two continuous variables, and the Chi-square test was employed to evaluate categorical data. A statistically significant level was defined as $P < 0.05$.

RESULTS: Based on the inclusion and exclusion criteria, this single centered prospective observational study comprised 81 patients admitted

for HF. **Table 1** displays the demographics of the patients at the time of admission. The study participants' median age was 61.5 years, with the majority (32.09%) being between 60 and 69 years old and the majority of the population being male (70.37%). The participants' average body weight was 64.40 kg, with 56.72% of participants falling below 65 kg.

TABLE 1: DEMOGRAPHICAL CHARACTERISTICS OF THE PARTICIPANTS

Variables	Frequency(n) n = 81	Percentage (%)
Gender Distribution		
Male	57	70.37
Female	24	20.62
Age (Years) (Mean ± SD)	61.5 ± 13.8	
Age Distribution (Years)		
20 to 29	2	2.46
30 to 39	6	7.40
40 to 49	4	4.93
50 to 59	16	19.75
60 to 69	26	32.09
70 to 79	22	27.16
80 to 89	5	6.17
Weight (Kg) (Mean ± SD)	64.40±10.85	
Weight Distribution (Kg)		
65 or less	46	56.72
65 to 90	33	40.74
More than 90	2	2.46

Table 2 displays the co-morbidity, type of heart failure, and presenting symptoms at the time of HF admission. The most common symptom in the study population was dyspnea (80.24%), followed by pedal edema (51.85%). Heart failure with decreased Ejection Fraction (HFrEF) was the most prevalent type of HF, accounting for 86.41% of cases. The co-morbid condition that was reported the most frequently was type 2 diabetes mellitus (72.83%).

TABLE 2: SYMPTOMS PRESENT, TYPE OF HEART FAILURE, AND COMORBIDITY ON HEART FAILURE ADMISSION

Categories	Frequency (n) n = 81	Percentage (%)
Presenting symptoms		
Giddiness	5	6.17
Sweating	15	18.51
Dyspnea	65	80.24
Dyspnea on exertion	23	28.39
Vomiting	8	9.87
Pedal Edema	42	51.85
Abdominal bloating	5	6.17
Decrease urine output	8	9.87
Cough	16	19.75
Chest pain	29	35.80
Palpitation	8	9.87
Types of Heart failure		
Heart Failure with reduced Ejection Fraction (HFrEF)	70	86.41
Heart Failure with Moderate Ejection Fraction (HFmrEF)	9	11.11
Heart Failure with perceived Ejection Fraction (HFpEF)	2	2.46
Co morbidity		
Type 2Diabetes Mellitus (T2DM)	59	72.83
Systolic Hypertension (SHTN)	45	55.55
Ischemic Heart Disease (IHD)	48	59.52
Cardiomyopathy (CM)	5	6.17
Chronic Obstructive Pulmonary Disease (COPD)	3	3.70
Hypothyroidism	8	9.87
Acute Pulmonaryedema (APE)	22	27.16
Acute Kidney Injury (AKI)	4	4.93
Chronic Kidney Disease (CKD)	4	4.93

Table 3 lists the most often prescribed medications at the time of discharge. In our study sample, the most common prescription was furosemide (80.24%), a loop diuretic, followed by aspirin (75.30%), a salicylate.

TABLE 3: THE MOST COMMON MEDICATIONS PRESCRIBED ON DISCHARGE

Drug (Drug class) Prescribed	Frequency (n) n = 81	Percentage (%)
Furosemide (Loop Diuretics)	65	80.24
Aspirin (salicylates)	61	75.30
Atorvastatin (Statins)	57	70.30
Spironolactone (Mineral corticoid Receptor Antagonist)	42	51.85
Bisoprolol (Beta Blockers)	23	28.39

Table 4 shows the length of hospital stay, compliance, and cardiac profiling of patients compared to admission and readmission. Both admission and readmission had nearly the same length of hospital stay, with no statistically significant (p = 0.453) difference in length of stay. There is a high association between compliance and readmission, as seen by the statistically significant (p = 0.007) difference between the noncompliance rates during admission (26.25%) and readmission (55.55%). NYHA Class III was the most common at admission (34.56%) and readmission (33.33%), and it was strongly (p=0.043) correlated with readmission.

TABLE 4: COMPRESSION OF LENGTH OF HOSPITAL STAY, COMPLIANCE, CARDIAC PROFILING OF THE HEART FAILURE PATIENTS ON ADMISSION AND READMISSION

Parameters	Admission (n = 81)	30 Days Readmission (n = 18)	P value
Length of stay (Days) (Mean ± SD)	5.61 ± 2.87	6.11 ± 3.93	0.453
Compliance (n (%))			
Yes	60 (74.07)	8 (44.44)	0.007*
No	21 (26.25)	10 (55.55)	
Cardiac profiling (NYHA Class) (n (%))			
Class I	17 (20.00)	5 (27.78)	0.472
Class II	21 (25.92)	3 (16.67)	0.458
Class III	28 (34.56)	6 (33.33)	0.043*
Class IV	15 (18.51)	4 (22.22)	0.674

Table 5 compares laboratory results, blood pressure, and echocardiogram results between admission, 30-day readmission, and non-readmission. Upon readmission, increased levels of NT proBNP, Troponin T, and HbA1C% were noted; however, the significance of the values was not established. in contrast, there was a significant correlation between readmission and the serum urea level (BUN) (p = 0.036) as well as the diastolic (p = 0.018) and systolic (p = 0.017) blood pressure. In terms of readmission, the percentage of ejection fraction was statistically negligible.

TABLE 5: COMPARISON OF LABORATORY VALUES, BLOOD PRESSURE, AND ECHOCARDIOGRAM OUTCOMES ON ADMISSION, 30 DAYS READMISSION, AND NO READMISSION

Variables	On Admission		30 Days Readmission				P Value
			No		Yes		
	Mean	SD	Mean	SD	Mean	SD	
Laboratory Values							
NT proBNP (pg/ml)	9739.1	10521.098	7032.70	7871.78	25075.3	11866.3	0.387
Troponin T (ng/L)	242.74	511.437	215.193	517.39	321.969	519.618	0.719
Sodium (mEq/dL)	134.95	5.461	135.381	4.538	133.44	7.883	0.331
Potassium (mEq/dL)	4.32	0.698	4.35	0.69	4.22	0.7	0.502
Creatinine (mg/dL)	1.24	0.66	1.152	0.5101	1.55	1.007	0.121
Hemoglobin (g/dL)	12.15	2.260	12.23	2.258	11.88	2.310	0.575
RBC (million/µL)	4.535	0.747	4.539	0.7619	4.522	0.733	0.952
HbA1C (%)	7.802	1.946	1.864	2.088	7.422	1.206	0.420
Urea (mg/dL)	47.209	35.42	38.22	22.71	86.5	53.430	0.036*
Blood Pressure (mmHg)							
Diastolic Blood pressure	74.88	1.45	76.920	12.226	67.77	13.956	0.018*

Systolic Blood pressure	120	23.68	124.17	23.47	109.5	21.27	0.017*
Echocardiogram Outcomes							
Ejection Fraction (%)	30.444	8.240	30.682	6.5026	29.61	12.82	0.735

Table 6 shows the correlation between readmission and demographic characteristics. In terms of readmission, males were predominant (72.2%). The most common age group for readmissions (27.78%) was 60–69 years. Nevertheless, our data does not show a significant correlation between age or gender and readmission.

TABLE 6: CORRELATION BETWEEN DEMOGRAPHICAL FACTORS AND READMISSION

Factor	30 days readmission		
	Yes (n=18)	No (n=63)	P value
Gender (n (%)			
Male	13(72.2)	44(69.84)	0.848
Female	5(27.7)	19(30.15)	0.845
Age (Years) (n (%)			
20-29	1 (5.56)	1 (1.59)	0.491
30-39	0 (0)	6 (9.52)	
40-49	1 (5.56)	3 (4.76)	
50-59	4 (22.22)	12 (19.05)	
60-69	5 (27.78)	21 (33.33)	
70-79	4 (22.22)	18 (28.57)	
80-89	3 (16.67)	2 (3.14)	

Table 7 shows the correlation between prescribed medicine and readmission. The readmission was positively (p = 0.001) correlated with the use of angiotensin-converting enzyme inhibitors (ACEI), suggesting that ACEIs prevent readmissions. The prescriptions for statins and loop diuretics contributed to the readmission in an equal amount (83%). However, they lacked statistical significance.

TABLE 7: CORRELATION BETWEEN PRESCRIBED MEDICATIONS AND READMISSION

Drug Class	30daysreadmission		P-Value
	Yes(n = 18) (n (%)	No(n = 63) (n (%)	
Angiotensin-converting enzyme inhibitors (ACEI)	0 (0)	6 (9.52)	0.001*
Angiotensin II receptor blockers (ARB)	2 (11.11)	3 (4.79)	0.441
Angiotensin receptor/neprilysin inhibitor (ARNI)	2 (11.11)	12 (19.04)	0.340
Beta-blockers	13 (72.22)	43 (68.20)	0.751
Loopdiuretics	15 (83.3)	52 (82.53)	0.936
Thiazidediuretics	4 (22.22)	4 (22.22)	0.140
Mineralocorticoid receptor antagonist (MRA)	9 (50.00)	41 (65.00)	0.276
Hyperpolarization-activated cyclic nucleotide-gated (HCN) channel blocker	3 (16.66)	11 (17.40)	0.938
Sodium-glucose cotransporter-2 (SGLT2) inhibitors	4 (22.22)	12 (19.04)	0.780
Statins	15 (83.33)	57 (90.47)	0.472
Cardiacglycosides	1 (5.55)	3 (4.76)	0.933
Antiarrhythmics	1 (5.55)	3 (4.76)	0.898
Calcium Channel Blockers (CCB)	1 (5.55)	6 (9.52)	0.557
Vasodilator	11 (61.11)	33 (52.3)	0.520
Antiplatelets	14 (77.70)	57 (90.00)	0.770
Anticoagulants	9 (50.00)	34 (53.90)	0.773
Insulin	6 (33.30)	18 (28.57)	0.713
Oral Hypoglycemic Agents (OHA)	2 (11.11)	9 (14.28)	0.721
Bronchodilators	3 (16.66)	7 (11.11)	0.579

DISCUSSION: Morbidity and mortality rates for HF patients are still high even with improvements in HF care. To lower healthcare costs, payers and healthcare providers have paid close attention to HF hospitalizations and readmissions. However, there is a great deal of variation in the clinical management of HF patients, which gives a significant possibility to enhance HF treatment.

In our single-centered prospective observational analysis, 81 hospitalized HF patients were enrolled, with around 71% being male. The study participants' median age was 61.5 years old. Our findings are consistent with other research, which found that men are more likely than women to be impacted by HF and people over 60 are the susceptible age group [6, 7].

HF patients might have a wide range of symptoms, the majority of which are non-specific. Dyspnea was the most common symptom in our study population, followed by pedal edema. Similar findings from a prior study indicated that fatigue, dyspnea, swelling ankles, and exercise intolerance are typical signs of HF [8]. In our study sample, the most common type of HF was HFrEF. This is consistent with earlier research in which over half of the individuals reported having HFrEF [9, 10]. T2DM is prevalent in South India and is a key risk factor for developing HF [10]. It should come as no surprise that T2DM mellitus was the most prevalent co morbidity in our research, and is a significant risk factor for heart failure. Furosemide, a loop diuretic, was the most commonly prescribed medication in our study sample, which is consistent with earlier findings [11].

There was no statistically significant variation in the length of hospital stay, showing that admission and readmission had nearly the same hospital stay. This is consistent with earlier research [11]. Noncompliance was observed in 55.55% of readmissions, with a statistically significant difference demonstrating a substantial link between compliance and readmission. As a result, compliance is inversely linked to readmission rates. Analogous findings from earlier research indicated that noncompliance was the primary reason for readmission[12, 13]. According to the cardiac profile, NYHA Class III was the most prevalent in admission and readmission, and it was strongly associated with readmission, showing that NYHA Class is one of the risk factors for readmission. In our investigation, increased levels of HbA1C%, Troponin T, and NTproBNP were noted upon readmission; however, the difference was not statistically significant. Both the diastolic and systolic blood pressure and serum urea level (BUN) were statistically substantially correlated with readmission. In readmission, the rejection fraction was statistically insignificant. Identical hose made in earlier research. In patients with heart failure, elevated amounts of cardiac troponin and NT-proBNP at admission are linked to a higher rate of mortality. These biomarkers have comparable associations with mortality and readmission in patients with chronic HF. Furthermore, elevated cardiac troponin levels are related to an increased risk of HF hospitalization, prolonged stays in an intensive care unit, and mortality. For hospitalized patients with HF, periodic biomarker assessment from admission to discharge may therefore be taken into consideration since available data indicates that lowering biomarker concentrations may enhance patient prognosis and help identify those who will most benefit from the optimization of guideline-directed medical therapy [14-17].

In our study on readmission, males were predominant. The most common age group for readmissions was 60–69 years old. Nevertheless, our data does not show a significant correlation between age or gender and readmission. The proportion of ACEI-using patients who did not experience a readmission in our study. The readmission and ACEI had a positive correlation, suggesting that ACEI prevents readmissions. The prescriptions for statins and loop diuretics both had an equivalent role in the readmission. They were not, however, statistically significant. According to a prior study, using ACEI-ARBs was linked to a much-decreased risk of mortality and 30-day all-cause readmission [18]. The following variables contributed to the readmission in this prospective observational study: non-compliance, NYHA class, co-morbidity (high blood pressure, renal disease, diabetes), and prescriptions without an ACEI.

HF guidelines indicate that patients hospitalized for HF be evaluated for triggering factors and that treating triggering factors is an important element of HF care. This study offers more proof in favor of these guidelines' suggestions. To avoid negative outcomes, patients with heart failure who have specific high-risk variables may benefit from closer monitoring and early management. Several of these triggering factors, including noncompliance, may be influenced by improving patient education and treatment techniques. A thorough management strategy for HF patients should include strategies

aimed at addressing recognized triggering variables that may or may not be linked to unfavorable outcomes to lower rehospitalization and mortality rates [19]. Although there are several underlying causes of HF, noncompliance was the most common contributing factor in our research. Rehospitalization can be avoided by identifying contributing variables, treating symptoms to a satisfactory degree, and closely monitoring patients. These actions can enhance both immediate and long-term results. In the HF population, future research should concentrate on evaluating therapies that target these contributing factors.

Limitation: The sample size and duration of follow-up are the primary limitations of this investigation. Small sample sizes may impact measurement variability. A larger prospective cohort or a randomized-controlled trial is required to comprehend the features and assess the impact of medications on the HF population. The study had selection bias as patients were recruited from a single center, which may not reflect the actual incidence of the HF population.

CONCLUSION: The noncompliance, high BUN, decreased EF, high blood pressure, poorly managed HbA1C, and lack of ACEIs were all substantially linked to HF readmission in our study. Since there is a significant risk of rehospitalization in HF patients, this study emphasizes that efforts should be made to mitigate the risk of readmission and mortality by focusing on improving medication adherence through patient education and managing co-morbidities.

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