ORIGINAL ARTICLE
ADMISSION AND READMISSION IN HEART FAILURE, PREDICTORS OF READMISSION, AN EXPERIENCE AT AYUB TEACHING HOSPITAL ABBOTTABAD

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Background: Heart failure is a long-term health condition that is characterized by multiple re-admissions throughout the patient's life. The economic burden and the impairment of quality of life are too prominent in patients with heart failure. The aim of the study was to determine re-admission rate and predictors of re-admission in patients with heart failure at Ayub Teaching hospital Abbottabad. **Methods**: A data of 350 patients with heart failure who were admitted & readmitted to the coronary care unit with heart failure were included in this study. Data was collected to determine the common factors that may dictate their readmission to hospital. **Results**: Over all re-admission rate was 58.28 %(n=204) for the patients in our study cohort. Regarding readmission rates within a 90-days period, 41.7% (n=146) of the sample had no readmission events, 35.1% (n=123) had one readmission, and 23.1% (n=81) experienced two or more readmissions. In terms of comorbid conditions, 36.9% (n=129) of the patients had a diagnosis of diabetes mellitus, while 57.7% (n=202) had hypertension. There was a statistically significant association between readmission within 90 days following first hospitalization for heart failure and diabetes mellitus, Increased Heart Rate, Nephropathy and an increased Neutrophil: Lymphocyte ratio ($p<0.05$). **Conclusion**: Diabetes mellitus, elevated heart rate, the presence of nephropathy, and an increased neutrophil-lymphocyte ratio were found to be independent predictors of subsequent heart failure readmission. These risk factors could potentially serve as simple indicators for forecasting the likelihood of heart failure readmission following patient discharge.

Keywords: Heart failure; Diabetes Mellitus; Morbidity & Mortality; Re-admission; Nephropathy

INTRODUCTION

Heart failure (HF) represents a significant public health concern due to its prevalent nature, high mortality, and the substantial rate of patient readmissions within one-year, exceeding 60%.[1–3] This alarming scenario underscores the critical need to delve deeper into the trends of HF-related hospitalizations, aiming to reduce their overall impact on health. A key focus should be on the relatively small group of HF patients who experience recurrent hospitalizations, as they disproportionately contribute to the overall morbidity, healthcare costs, and mortality.[4,5] However, research on this high-risk group has been relatively scant.

Older individuals suffering from heart failure (HF) often experience recurrent episodes of disease worsening. These episodes are frequently linked to several contributing factors including suboptimal treatment adherence, adverse reactions to medications, insufficient social and economic support, multiple health conditions, and the absence of ongoing monitoring systems.[6] Additionally, renal impairment can significantly limit the use of various crucial therapeutic approaches and life-saving treatments.[7] A range of factors exacerbate HF, such as coexisting illnesses that cause structural cardiac abnormalities, for instance, diabetes, high blood pressure, atherosclerosis, and metabolic disorders.[8]

Acute HF is associated with a multitude of risk factors. These include hypertension, coronary artery disease, myocarditis, diseases of the heart valves, cardiomyopathies, diseases of the pericardium, congenital heart defects, endocarditis, disturbances in heart rhythm, arrhythmias, conditions leading to high cardiac output (e.g., those caused by sepsis, anemia, and arteriovenous fistulas).[8]

A specific community-based study revealed that over a 4.7-year period, 66.9% of HF patients were hospitalized at least twice, 53.6% three times or more, and 42.6% four times or more.[9] Interestingly, over 60 (61.9%) of these readmissions were due to non-cardiovascular reasons. While many studies have examined predictors of readmissions, whether total or HF-specific, most have generalized across all readmission instances.[9–11] Yet, a study in the U.S. indicated that socioeconomic challenges and belonging to a minority racial group were significant factors in predicting two or more readmissions within a year.[12]

In the heart failure (HF) patient demographic, non-cardiovascular illnesses are frequently observed and can exacerbate cardiac disease progression and multi-organ dysfunction, potentially increasing hospital readmission rates. An analysis of Medicare data by Aranda *et al*. in 2009 highlighted that HF was responsible for 28% of all hospital readmissions within 6–9 months post-initial HF hospitalization, with pneumonia and chronic obstructive pulmonary disease being significant contributors.[10] It was noted that patients experiencing more frequent readmissions often had comorbid conditions such as diabetes, peripheral vascular disease, and stroke, compared to those HF patients who were not readmitted following their initial hospital stay.[10] The prevalence of diabetes mellitus is notably high among individuals with HF.[13] Furthermore, hyperkalemia was identified as a notable factor in the readmitted group, potentially resulting from the side effects of ACE inhibitors and potassium-sparing diuretics. This factor, however, might be influenced by confounding due to its occurrence in both the readmitted and non-readmitted groups, a situation that could be mitigated by loop diuretics.[14] A substantial portion of healthcare costs can be attributed to readmissions following an initial HF hospitalization. Economic constraints may lead to cost-related non-compliance with medical treatments and guidelines, adversely affecting patient outcomes and potentially resulting in further hospitalizations and readmissions, thereby exerting financial strain on the healthcare system.[15] The rate of readmission among HF patients is notably high, with about half requiring re-hospitalization within six months of their initial admission.[10] Additionally, both the duration of hospital stays and the frequency of readmissions have been linked to poorer prognoses and heightened mortality risk.[10] The challenge in developing targeted interventions for patients with frequent readmissions lies in the difficulty of pinpointing their clinical predictors. Additionally, the effectiveness of HF disease management programs could be substantially improved with early identification of these high-risk individuals.

This cross-sectional study aimed to investigate the multifaceted factors influencing the readmission rates of heart failure (HF) patients. HF is a significant public health issue, marked by high prevalence and mortality, alongside a notable economic burden of frequent patient readmissions. This study seeks to delve into the complex interplay of various elements contributing to these readmissions. Key areas of focus include the impact of non-cardiovascular comorbidities such as diabetes and peripheral vascular disease, which are more common in patients with recurrent hospitalizations. Additionally, the study will explore the influence of socioeconomic and demographic factors on readmission rates, acknowledging their role in patient outcomes. This research is vital in identifying clinical predictors and understanding the broader determinants of health affecting HF patients. The findings are expected to inform more effective management strategies and interventions, aiming to improve patient care and reduce the healthcare system's burden. By offering insights into the diverse factors behind HF readmissions, the study could pave the way for more personalized and efficient healthcare approaches for this high-risk patient group.

MATERIAL AND METHODS

This study constituted a forward-looking, observational investigation, conducted exclusively at a single center between November 2022 and June 2023. During this timeframe, 350 patients diagnosed with cardiac insufficiency were admitted to the cardiology unit at Ayub Teaching Hospital (ATH), Abbottabad. The study employed a Convenience Sampling technique. Inclusion criteria encompassed patients aged 18 or above, diagnosed with any stage of heart failure, and admitted for treatment, following informed consent acquisition. Exclusion criteria included pregnant women, individuals without heart failure, and those less than 18 years of age. Medical records of each patient from admission to discharge were meticulously evaluated. Data collection was facilitated using a structured patient profile form, capturing demographic information, medical history, cardiac insufficiency stages according to NYHA guidelines, vital signs, laboratory findings including Neutrophil and Lymphocyte counts, Neutrophil-Lymphocyte ratio, ejection fraction, and pre- and post-hospitalization

medication adherence. Additionally, data encompassed conditions like Diabetes, Hypertension, and Kidney dysfunction. Factors influencing re-hospitalization and frequent admissions were extracted from medical records. The data gathering process involved identifying each patient, reviewing their medical history, and documenting information as per the specified form. Selection of participants was guided by predetermined inclusion and exclusion criteria. Upon data collection, analysis of the 350 patient records was conducted using SPSS software. Patient compliance was ascertained through physician reports and direct interactions with patients or their primary caregivers. The analysis entailed descriptive statistics for categorical data (frequency and percentage) and for numerical data (mean and standard deviation or median and interquartile range). Comparisons between readmitted and non-readmitted patients utilized the independent t-test for numerical data, and Chi-Square or Fisher's exact test for categorical data. Statistical significance was assigned to p-values less than 0.05, with SPSS software version 26 used for all analyses.

RESULTS

This study enrolled individuals, with ages ranging from 43–84 years, and an average age of 64.10 years (SD=12.077). The total leukocyte counts among the participants varied widely, with a minimum of 3500 cells/cm³ and a maximum of 25800 cells/cm³, yielding an average count of 10326.44 cells/cm³ (SD=3729.605). For polymorphonuclear cells, counts ranged from 500–21900 cells/cm³, with an average of 8068.61 cells/cm³ (SD=3352.858). Lymphocyte counts spanned from 257–3890 cells/cm³, with a mean value of 948.68 cells/cm³ (SD=518.091). The neutrophil to lymphocyte ratio exhibited a broad range from 0.92–50.00, with an average ratio of 10.7928 (SD=6.84619). The ejection fraction percentage among the cohort ranged from 15–42%, with a mean ejection fraction of 29.05% (SD=6.284). The table presents list-wise valid data for all 350 cases. (Table-1)

The group statistics section of the analysis delineated two subsets of participants based on the occurrence of readmission within 60 days. For those readmitted (N=204), the mean age was 64.75 years (SD=11.938), the neutrophil-to-lymphocyte ratio averaged at 14.4460 (SD=6.75795), and the mean ejection fraction was calculated at 29.40% (SD=6.451). The participants who were not readmitted (N=146) had a mean age of 63.19 years (SD=12.253), a neutrophil-to-lymphocyte ratio

mean of 5.6884 (SD=1.96541), and an average ejection fraction of 28.57% (SD=6.031).

The independent samples t-test evaluated the equality of means between the two groups. For age, the t-test revealed no significant difference (t (348) =1.191, p=.235). However, a significant difference was found in the neutrophil-to-lymphocyte ratio between the groups (t-(348)=15.200, p<.001), with a mean difference of 8.75763 (95% CI [7.62440, 9.89085]). The ejection fraction also showed no significant difference (t (348) =1.217, p=.224).

Levene's Test for Equality of Variances presented non-significant results for age (F=.036, p=.849) and ejection fraction (F=.535, p=.465), indicating homogeneity of variances. In contrast, the test was significant for the neutrophil-to-lymphocyte ratio (F=91.496, p<.001), suggesting variance heterogeneity between the groups for this variable.

In the analyzed sample of 350 patients, the distribution of gender was as follows: males constituted 61.4% (n=215) while females made up 38.6% (n=135). Regarding readmission rates within a 60-day period, 41.7% (n=146) of the sample had no readmission events, 35.1% (n=123) had one readmission, and 23.1% (n=81) experienced two or more readmissions. In terms of comorbid conditions, 36.9% (n=129) of the patients had a diagnosis of diabetes mellitus, while 57.7% (n=202) had hypertension. The remaining 63.1% (n=221) did not have diabetes, and 42.3% (n=148) were not diagnosed with hypertension. Within the patient population under investigation (N=350), heart rate categorization was as follows: 22.3% (n=78) had a heart rate of less than 80 beats per minute, 42.9% (n=150) had a heart rate between 80 and 100 beats per minute, and 34.9% (n=122) exhibited a heart rate exceeding 100 beats per minute. The occurrence of nephropathy was confirmed in 56.6% (n=198) of the patients, while the remaining 43.4% (n=152) did not present with this condition. Adherence to prescribed treatment was noted in 24.6% (n=86) of the cases, with the majority, 75.4% (n=264), not complying with the treatment regimen.

Readmission in the following 60 days in our patient population was stratified by age, sex, presence of diabetes, hypertension, nephropathy, increasing heart rate, treatment compliance. Post stratification chi-square was done and it was found that there was a statistically significant association between presence of diabetes, nephropathy, increasing heart rate and readmission to the hospital within 60 days (p <0.05).

Table-1: Descriptive statistics of study population

	N	Minimum	Maximum	Mean	Std. Deviation
Age (yrs)	350	43	84	64.10	12.077
Total Leukocyte Count / cm3	350	3500	25800	10326.44	3729.605
Polymorphonuclear cells/cm3	350	500	21900	8068.61	3352.858
Lymphocytes /cm3	350	257	3890	948.68	518.091
Neutrophils:Lymphocyte Ratio	350	0.92	50.00	10.7928	6.84619
Ejection Fraction (%)	350	15%	42%	29.05%	6.284
Valid N (listwise)	350				

Table-2: Independent sample T-test for comparison between the two groups

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Age (yrs)		.036	.849	1.191	348	.235	1.558	1.308	-1.015	4.132
	Equal variances not assumed			1.186	307.552	.237	1.558	1.314	-1.028	4.144
Neutrophils: Lymphocyte Ratio	Equal variances assumed	91.496	.000	15.200	348	.000	8.75763	.57617	7.62440	9.89085
	Equal variances not assumed			17.504	248.950	.000	8.75763	.50033	7.77221	9.74305
Ejection Fraction (%)	Equal variances assumed	.535	.465	1.217	348	.224	.829	.681	-.510	2.167
	Equal variances not assumed			1.231	324.360	.219	.829	.673	-.496	2.153

Table-3: Frequencies of various demographic parameters in study population

SEX			Frequency	Percent	Valid Percent	Cumulative Percent
Valid		Male	215	61.4	61.4	61.4
		Female	135	38.6	38.6	100.0
		Total	350	100.0	100.0	
Number of readmissions in 60 days						
Valid		No re admission	146	41.7	41.7	41.7
		1 readmission	123	35.1	35.1	76.9
		at least 2 re admissions	81	23.1	23.1	100.0
		Total	350	100.0	100.0	
Diabetes Mellitus						
Valid	Yes	129	36.9	36.9	36.9	
	No	221	63.1	63.1	100.0	
	Total	350	100.0	100.0		
Hypertension						
Valid	Yes	202	57.7	57.7	57.7	
	No	148	42.3	42.3	100.0	
	Total	350	100.0	100.0		
Heart Rate (beats per minute)						
Valid	Less than 80	78	22.3	22.3	22.3	
	Between 80 and 100	150	42.9	42.9	65.1	
	More than 100	122	34.9	34.9	100.0	
	Total	350	100.0	100.0		
Nephropathy						
Valid	Yes	198	56.6	56.6	56.6	
	No	152	43.4	43.4	100.0	
	Total	350	100.0	100.0		
Treatment Compliance						
Valid	Yes	86	24.6	24.6	24.6	
	No	264	75.4	75.4	100.0	
	Total	350	100.0	100.0		

Table-4: Cross tabulation of re admission with selected variables

		Diabetes Mellitus		Total	
		Yes	No		p value
Readmission within 60 days	Yes	99	105	204	
	No	30	116	146	.000
Total		129	221	350	
		Heart Rate (beats per minute)			Total	
		Less than 80	Between 80 and 100	More than 100		p value
Readmission within 60 days	Yes	12	85	107	204	
	No	66	65	15	146	.000
Total		78	150	122	350	
		Nephropathy		Total	
		Yes	No		p value
Readmission within 60 days	Yes	165	39	204	
	No	33	113	146	0.000
Total		198	152	350	

DISCUSSION

In individuals diagnosed with heart failure (HF), the implications of recurrent hospital admissions for both the healthcare infrastructure and patient survival rates have been extensively documented.[1–4] Yet, the bulk of research has centered on determining predictors for any subsequent hospital admission, rather than focusing on the subset of patients with multiple readmissions, who disproportionately impact overall morbidity, mortality, and healthcare expenditures.[16,17] Within our heart failure cohort, the 23.1% of patients experiencing two or more readmissions within a 60-days of discharge from hospital accounting for 39.7% of all subsequent hospital stays. Our findings indicate that the community prognosis for heart failure patients is notably adverse, with the highest risk observed in patients with co-existing diabetes mellitus, elevated heart rates at discharge post-initial admission, nephropathy, and a raised Neutrophil to Lymphocyte ratio. These outcomes underscore the critical need for effective glycemic control, ensuring sufficient fluid intake to avert renal complications, optimizing treatments to regulate heart rate, and addressing inflammatory conditions during the initial hospital stay. The elevated rates of readmission linked to heart failure predominantly stem from these underlying conditions. Furthermore, our findings suggest that the presence of comorbidities in patients with HF may lead to an uptick in readmissions not directly related to heart failure. Therefore, broader intervention strategies that include management of these comorbidities, in tandem with conventional heart failure treatment protocols, are imperative to curb both readmission rates and mortality.

Of the 350 patients evaluated post-initial acute HF discharge in this study, 204 experienced readmissions. The aggregated incidence of readmission at the 60-day mark stood at 58.28%, which is alarmingly substantial. A statistically significant association was identified between the presence of diabetes mellitus and the likelihood of readmission. An elevated heart rate at discharge was typically observed in patients who were readmitted. Indications of nephropathy, inferred from abnormal renal function tests, were linked to a heightened risk of hospital readmission within a subsequent 60-day period. Previous research has indicated that older HF patients generally have poorer prognoses, attributable to differences in etiology, comorbidity profiles, left ventricular (LV) functionality, including both systolic and diastolic aspects, and complexities in management owing to multiple coexisting conditions, thereby complicating the application of evidence-based treatments.[18–20] Contrary to these findings, our cohort did not exhibit a notable age-related escalation in hospital readmission rates.

The relationship between diabetes mellitus (DM) and an increased risk of HF, irrespective of concurrent coronary artery disease or hypertension, has been well-established. DM can potentially lead to diabetic cardiomyopathy, thereby impairing LV function. The Framingham Study previously substantiated the tight coupling between DM and HF,[21] and the hazard of HF manifestation in DM patients has been linked to the degree of hyperglycemia.[22,23] Nonetheless, intensive glycemic management has not demonstrated a reduction in HF onset among DM patients.[24] Additionally, the prescription of certain antidiabetic medications to HF patients presents challenges. Prior studies have demonstrated that elevated heart rates are associated with increased mortality from all causes and cardiovascular events, with heart failure patients presenting with increased resting heart rates.[25-27] Conversely, extensive clinical research on beta-blockers in chronic HF patients has also suggested a link between mortality reduction and the extent of heart rate decrease[28,29] positioning beta-blockers as potentially beneficial for heart rate moderation in HF patients. The findings of this research indicate significant associations between neutrophil-to-lymphocyte ratio (NLR) and readmission frequencies in individuals with acute heart failure. Furthermore, NLR serves as an independent prognostic factor for mortality within the hospital and for duration of three years post-discharge. In a prior investigation that monitored approximately 1,200 patients with acute decompensated heart failure over a period of 26 months, it was found that subjects with an increased NLR experienced a notably higher rate of 30-day readmissions and elevated long-term mortality in comparison to those with lower NLR levels.[30] Benites-Zapata *et al.* also reported that an elevated NLR is associated with a heightened risk of mortality or the necessity for heart transplantation in advanced stages of heart failure.[31] It is, however, important to note that the scope of these studies is constrained by their focus on a limited patient cohort from single centers and by their retrospective design.

CONCLUSION

Readmission due to heart failure was prevalently observed among patients discharged from their initial acute heart failure hospitalization. Diabetes mellitus, elevated heart rate, the presence of nephropathy, and an increased neutrophil-lymphocyte ratio were found to be independent predictors of subsequent heart failure readmission. These risk factors could potentially serve as simple indicators for forecasting the likelihood of heart failure readmission following patient discharge. Based on finding of this study, at the time of discharge adequate heart rate control, treatment of infective etiology, management of nephropathy, adequate glycemic control, counseling regarding compliance to treatment, weight monitoring at home and low salt intake are strongly recommended to reduce readmission in patients with heart failure.

Study limitations:

This study is subject to certain limitations. Conducted in a specialized cardiovascular unit within a single institution, the findings may not be extrapolatable to broader medical settings. Additionally, the modest cohort size may restrict the

robustness of the statistical analyses, potentially rendering any non-significant findings inconclusive. Being an observational study with a cross-sectional design, the potential for unaccounted confounding variables to affect the outcomes cannot be dismissed.

AUTHORS' CONTRIBUTION

MSA: Data collection & literature Search. MKI: Data analysis. MK: Data interpretation. DN: Proofreading. RA: Study design. SJ: Write up.

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