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Original Article

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In-Hospital Mortality Rate and Predictors of 30-Day Readmission in Patients With Heart Failure Exacerbation and Atrial Fibrillation: A Cross-Sectional Study

Karthik Gangu, MD[1], Aniesh Bobba, MBBS[2], Harleen Kaur Chela, MD[1], Sindhu Avula, MD[3], Sanket Basida, MBBS[4], and Neha Yadav, MBBS[5]

[1]Division of Hospital Medicine, Department of Medicine, University of Missouri, Columbia, MO, USA
[2]Division of Hospital Medicine, Department of Medicine, John H. Stroger Hospital of Cook County, Chicago, IL, USA
[3]Division of Interventional Cardiology, Department of Cardiovascular Medicine, University of Kansas Medical Center, Kansas City, KS, USA
[4]Department of Medicine, Pandit Deendayal Upadhyay Medical College, Rajkot, India
[5]Division of Heart and Vascular, Department of Cardiology, John H. Stroger Hospital of Cook County, Chicago, IL, USA

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Correspondence to
Karthik Gangu, MD
Division of Hospital Medicine, Department of Medicine, Division of Hospital Medicine, University of Missouri Columbia, 1 Hospital Drive, DC046.00, Columbia, MO 65212, USA.
Email: krgbcq@umsystem.edu

ORCID iDs
Karthik Gangu
https://orcid.org/0000-0001-5134-5672
Aniesh Bobba
https://orcid.org/0000-0002-9932-9345
Harleen Kaur Chela
https://orcid.org/0000-0003-0658-1857

ABSTRACT

Background and Objectives: Heart failure (HF) and atrial fibrillation (AF) are considered new cardiovascular epidemics of the last decade. Recent national trends show an uptrend in HF hospitalizations. We aimed to identify the 30-day readmission rate, causes, and impact on healthcare utilization in HF exacerbation with a history of AF.
Methods: We utilized 2018 Nationwide readmission data and included patients aged ≥18 years with International Classification of Diseases, Tenth Revision, Clinical Modification code indicating HF exacerbation and AF were included in the study. Primary outcome is 30-day readmission rates. Secondary outcomes were mortality rates, common causes of readmission, and healthcare utilization. Independent predictors for readmission were identified using cox regression analysis.
Results: The total number of admissions in our study was 48,250. The mean age was 77.8 years (standard deviation, 12.1), and 47.74% were females. The 30-day readmission rate was 16.72%. The mortality rate at index admission and readmission was 7.28% and 8.12%, respectively. The most common cause of readmission was the hypertensive heart and kidney disease with HF. The independent predictors of readmission were low socio-economic class, Medicaid, Charlson comorbidities score. The financial burden on healthcare for all the readmission was $461 million for the year 2018.
Conclusions: The 30-day readmission rate was 16.72%. The mortality rate increased from 7.28% to 8.12% with readmission. The financial burden for readmission during that year was $461 million. Future studies directed with interventions to prevents readmissions are warranted.

Keywords: Thirty-day readmission; Diastolic heart failure; Systolic heart failure; Atrial fibrillation

Sindhu Avula
https://orcid.org/0000-0002-1338-5216
Sanket Basida
https://orcid.org/0000-0002-1029-6453
Neha Yadav
https://orcid.org/0000-0002-3492-723X

Conflict of Interest
The authors have no financial conflicts of interest.

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INTRODUCTION

Data from Framingham Heart Study participants showed that atrial fibrillation (AF) occurs in more than half of individuals with heart failure (HF), and HF occurs in more than one-third of individuals with AF.[1] It is estimated that around 6.2 million people in the US have HF.[2] Approximately 13.4% of deaths in 2018 have HF mentioned in the death certificate.[2] HF exacerbation poses a major financial burden on society, and it was estimated to cost around $30.7 billion in 2012.[3]

AF and HF share common risk factors.[4] Prevalence of AF has been reported to range from 27% to 65% in HF patients with increasing rates in HF with preserved ejection fraction (HFpEF). AF is associated with increased long-term mortality and morbidity.[5-8] Data from the Swedish Heart Failure registry[6] showed AF increased hazards of HF hospitalizations regardless of the ejection fraction over 12-year period, and the European Society of Cardiology-Heart Failure long-term registry[7] showed an increased risk of hospitalizations in HF with mildly reduced ejection fraction and HFpEF. Data from US Medicare beneficiaries between 2006–2008 showed increased all-cause readmission at 1 year.[9]

The data on the effect of AF on HF exacerbation over the short term is lacking. In 2014, Medicare and Medicaid shifted from fee-for-service to value-based reimbursement, leading to the increased focus on preventing 30-day readmissions. Currently, there is limited information on the predictors of these short-term outcomes and the utilization of resources in patients with HF and AF. This study, aimed to identify the 30-day readmission rate, causes, and impact on healthcare in HF exacerbation with a history of AF.

METHODS

Data source

Nationwide Readmissions Database (NRD) year 2018 was utilized for retrospective analysis. NRD can be obtained from the Healthcare Cost and Utilization Project, which is sponsored by Agency for Healthcare Research and Quality. Unweighted 2018 NRD contains approximately 18 million discharges for that year, while weighted sample estimates around 35 million discharges in the US. NRD draws its sample from 28 states, which represent 59.7% of the total US population and 58.7% of all US hospitalizations.[10]

Study population

Patients with age ≥18 years and non-elective admission with a principal diagnosis of acute HF or acute hypoxic respiratory failure with a secondary diagnosis of HF. All patients included in the study had a secondary diagnosis of AF. December month admissions were excluded as data regarding 30-day readmission cannot be calculated. International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10 CM) codes were utilized to identify the patient sample.

Variable selection

Variables included in the study were divided into patient level, illness severity, and hospital level:

a. Patient level: Age, sex, median household income in the zip code, insurance status, Charlson comorbidity score

b. The severity of illness: Mechanical ventilation, cardiogenic shock, length of stay, rehabilitation transfer
c. Hospital level: Hospital location, teaching status, bed size

Study outcomes

The primary outcome was all cause 30-day readmission, and any non-traumatic admission within 30 days of discharge after index admission was considered readmission. Secondary outcomes were In-hospital mortality, 30-day mortality following index admissions, top 5 principal reasons for readmissions, total length of stay and resource utilization associated with readmissions, independent predictors of readmission.

Statistical analysis

All statistical analysis was performed using the Stata 17.0 version (StataCorp LLC, College Station, TX, USA). Categorical variables were compared using the χ^2 test, and linear regression was used for continuous variables. A 2-tailed p value of ≤0.05 was considered statistically significant. All p values of ≤0.2 on univariate Cox regression were used to build a multivariate Cox regression model to identify independent predictors.

RESULTS

Patient characteristics

A total of 48,250 patients were included in the study after excluding patients as shown in **Figure 1**. Patient and hospital level characteristics are shown in **Table 1**. Females comprised 47.74%, with a mean age of 77.8 (standard deviation, 12.1). A total of 80.77% of the population was of age ≥65 years. Majority of patients had Charlson comorbidity score of ≥3 and Medicare insurance. Half of the patients were treated in large hospitals.

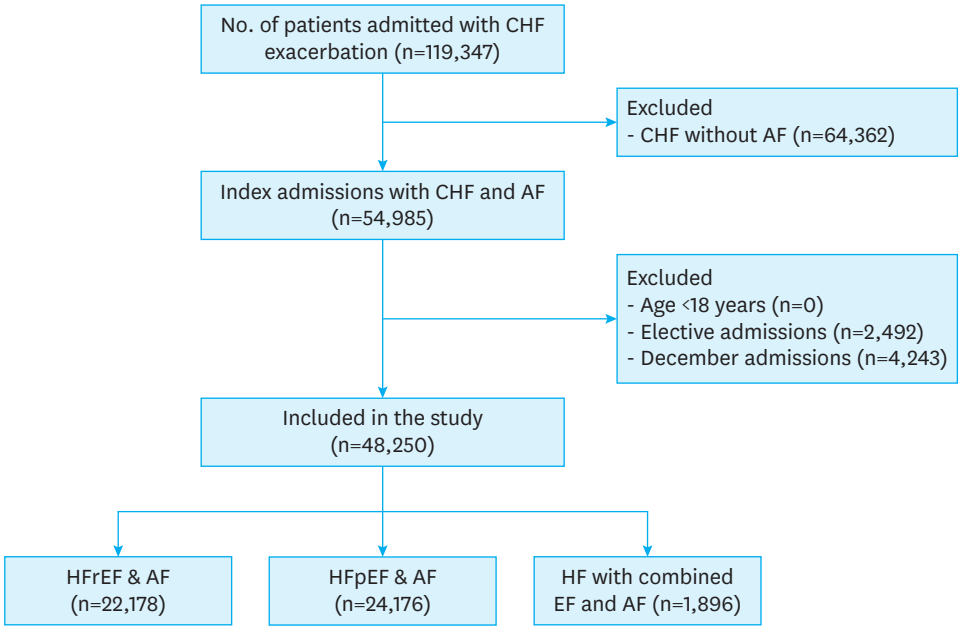

Figure 1. Inclusion and exlusion criteria.
CHF = congestive heart failure; AF = atrial fibrillation; HFrEF = heart failure with reduced ejection fraction; HFpEF = heart failure preserved ejection fraction; EF = ejection fraction.

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Table 1. Index hospitalization patient characteristics with CHF and AF (n=48,250)

Variable	Value
Age (years)	
18–44	1.86%
45–64	17.35%
65–84	51.13%
≥85	29.64%
Mean age (years)	
Female	77.8±12.1
Male	73.3±13.4
Sex (female)	47.74%
Median income in patients zip code ($)	
<45,999	25.76%
46,000–58,999	30.26%
59,000–78,999	24.96%
>79,000	18.99%
Insurance	
Medicare	82.12%
Medicaid	6.62%
Private	9.83%
Uninsured	1.41%
Charlson comorbidity score	
≤2	17.36%
≥3	82.64%
Hospital location	
Large metropolitan area	49.63%
Small metropolitan area	37.1%
Micropolitan area	9.7%
Not metropolitan or micropolitan area	3.55%
Teaching hospital	64.47%
Hospital bed size	
Small	21.42%
Medium	28.09%
Large	50.47%
Discharge to rehabillitation	0.87%

Values are presented as frequency (%) or mean±standard deviation.
CHF = congestive heart failure; AF = atrial fibrillation.

Thirty-day all cause readmission

Of 48,250 patients with congestive heart failure (CHF) and AF, 44,736 were discharged alive, of which 7,469 (16.7%) were readmitted in 30 days. Of 64,362 CHF patients without AF, 61,104 were discharged alive, of which 10,012 (16.38%) were readmitted in 30 days.

In-hospital mortality rate for index admission vs. readmission and 30-day mortality rate following index admission

A total of 3,514 (7.28%) died during the index hospitalization, and additional 501 patients died within 30 days of discharge. The mortality rate during readmission was higher when compared to index admission (8.12% vs. 7.28%, p=0.05). Comparison between index and readmission is show in **Table 2**. Further subgroup analysis showed readmission rate was 16.51% and 16.7% respectively in HFpEF and HF with reduced ejection fraction (HFrEF). **Table 3** represents the information on mortality, mechanical ventilation, cardiogenic shock, length of stay, and total charges of both the groups.

Most common all cause 30-day readmission

The most common reason for readmission was HF. **Table 4** shows the five most common reasons for readmissions. Four out of 5 reasons for readmissions were due to HF.

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Table 2. Comparison between index admission and readmission in patients with CHF and AF

Variable	Index	Readmission	p value
Sample size	48,250	7,469	
Died	3,514 (7.28%)	612 (8.12%)	0.05
Mechanical ventilation (%)	22.06	15.81	<0.001
Cardiogenic shock (%)	5.01	3.23	<0.001
Length of stay (days)	6.4	6.1	0.007
Total charges ($)	65,741	61,693	0.01

CHF = congestive heart failure; AF = atrial fibrillation.

Table 3. Comparison between index admission and readmission in HF and AF

Variable	Index	Readmission	p value
HFpEF and AF			
Sample size	24,176	3,734 (16.51%)	
Died (%)	6.47	8.88	<0.001
Mechanical ventilation (%)	20.1	16.44	<0.001
Cardiogenic shock (%)	1.52	1.05	0.11
Length of stay (days)	6.15	6.18	0.83
Total charges ($)	55,690	57,971	0.2
HFrEF and AF			
Sample size	22,178	3,433 (16.7%)	
Died (%)	7.24	7.82	0.42
Mechanical ventilation (%)	20.36	13.85	<0.001
Cardiogenic shock (%)	8.27	5.49	<0.001
Length of stay (days)	6.5	6.02	0.01
Total charges ($)	75,035	65,971	0.01

HF = heart failure; AF = atrial fibrillation; HFpEF = heart failure preserved ejection fraction; HFrEF = heart failure with reduced ejection fraction.

Table 4. Most common all cause 30-day readmission

Cause
1. Hypertensive heart and kidney disease with heart failure (14.6%)
2. Hypertensive heart disease with heart failure (10.86%)
3. Sepsis, unspecified organism (5.88%)
4. Acute on chronic systolic heart failure (5.66%)
5. Acute on chronic diastolic heart failure (5.17%)

Resource utilization due to readmissions

The mean length of stay (LOS) for readmitted patients was 6.1 days when compared to index admission 6.4 days (p<0.01). Mean hospitalization charges in readmission vs. index admission were $61,693 vs. $65,741 (p=0.01). Comparison between index and readmission is show in **Table 2**. Total LOS incurred due to readmission was 45,706 days, with resulting total hospitalization charges of $461 million.

Independent predictors of readmission

Variable selection, multivariate cox regression model building is described in the methods section. Independent predictors for 30-day readmission were higher Charlson comorbidity score, lower median income in patients zip code, Medicare, and Medicaid insurance. Predictors associated with decreased 30-day readmission were age, private insurance, and high median income in patient's zip codes. The rest of the variables were not linked to readmission, as shown in **Table 5**.

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Table 5. Predictors for readmission

Factors	Univariate HR (95% CI)	p value	Multivariate* HR (95% CI)	p value
Age	0.99 (0.98–0.99)	<0.001	0.99 (0.98–0.99)	<0.001
Female	0.97 (0.9–1.04)	0.42	-	-
Median income ($)				
>79,000	Reference		Reference	
59,000–78,999	1.06 (0.96–1.17)	0.21	1.06 (0.95–1.18)	0.24
46,000–58,999	1.04 (0.94–1.16)	0.34	1.05 (0.94–1.17)	0.31
<45,999	1.17 (1.06–1.29)	<0.001	1.14 (1.03–1.26)	0.01
Insurance				
Private	Reference		Reference	
Medicare	1.17 (1.04–1.32)	0.008	1.29 (1.13–1.48)	<0.001
Medicaid	1.62 (1.4–1.89)	<0.001	1.47 (1.27–1.72)	<0.001
Uninsured	1.19 (0.88–1.62)	0.24	1.11 (0.81–1.53)	0.48
Charlson comorbidity score	1.06 (1.04–1.06)	<0.001	1.06 (1.04–1.08)	<0.001
Hospital location				
Large metropolitan area	Reference		Reference	
Small metropolitan area	0.95 (0.88–1.02)	0.18	0.95 (0.88–1.03)	0.22
Micropolitan area	0.91 (0.79–1.03)	0.15	0.9 (0.77–1.05)	0.18
Not metropolitan or micropolitan area	0.87 (0.7–1.09)	0.2	0.92 (0.73–1.18)	0.54
Teaching hospital	1.06 (0.99–1.14)	0.07	1 (0.92–1.09)	0.82
Hospital bed size				
Small	Reference		Reference	
Medium	1.04 (0.94–1.14)	0.43	1.01 (0.91–1.11)	0.82
Large	1.07 (0.98–1.17)	0.09	1.03 (0.94–1.13)	0.49
Mechanical ventilation	1.06 (0.98–1.15)	0.11	0.95 (0.87–1.04)	0.32
Cardiogenic shock	0.96 (0.81–1.14)	0.66	-	-
Discharge to rehab	1.37 (0.99–1.9)	0.052	1.2 (0.86–1.73)	0.25
Length of stay	1.007 (1.003–1.01)	<0.001	1 (0.99–1)	0.06

HR = hazard ratio.
*Adjusted to age, median income, insurance, Charlson comorbidity score, hospital location, teaching location, hospital bed size, mechanical ventilation, discharge to rehab, length of stay.

DISCUSSION

Our study has several important findings. Firstly, among patients admitted with HF exacerbation with AF, the all-cause readmission rate was 16.7% within the first 30 days of discharge from index hospitalization, and the leading cause of readmission was HF. Second, low socioeconomic status, Charlson comorbidity score, and lower median income, Medicare and Medicaid insurance were predictors for increased 30-day readmission. Third, the mortality rate during readmission was higher when compared to index admission (8.12% vs. 7.28%, p=0.05).

The 30-day readmission rate in the US is significantly higher at 16.7% compared to 9.9% from a similar population-based study in Australia.[11] However, this is consistent with rates of HF readmission rate in the US, which was at 18.2% based on the national readmission database.[12] Our study showed a similar rate of readmission in patients with HF with underlying AF. The data on the effect of AF on HF readmission is variable. A metanalysis by Saito et al.[13] revealed that having AF did not increase the risk of HF short-term readmission. Similar results were found in smaller studies in the US population,[14] the Japanese population,[15][16] and the Spanish population.[17] Ahmed et al. showed similar findings in patients older than 65 years using Medicare data, that AF did not increase the 30 days readmission.[18]

Having AF by itself did not increase the short-term readmission rate for HF. This might be due to advances in the management of AF in terms of ablation techniques,[19] an

increase in the use of antiarrhythmics, novel oral anticoagulants, improvements in cardiac resynchronization therapy, and permanent pacemakers.[20] Patients with both HF and AF are likely to have well-established outpatient care, given the complexity of management which might help prevent short-term readmissions.

In contrast to our results, Eapen et al.[21] showed a modest increase in the 30-day readmission rate with increased hazards of 1.09 using Medicare claims data. However, a larger study sample and an all-payer source database are some of the unique features of our study. The most common cause of readmission remains HF exacerbation, similar to previous studies.[11][12][22]

Like prior evidence in HF,[12][23-26] our study revealed low socioeconomic status, Charlson comorbidity score, and lower median income, Medicare and Medicaid insurance were predictors for increased 30-day readmission. Around 90% of patients included in the study either had Medicare or Medicaid, and they had a high chance of readmission (29% and 47%) compared to patients with private insurance. A likely explanation might be the lack of Medicare part B and D coverage, which provides outpatient services. At the same time, very sick patients with low socioeconomic status and no insurance are likely to apply for Medicaid and have poor access to health care. These findings stress the importance of policies specifically geared towards patients of low socioeconomic status and hospitals taking care of these populations.[27] We did not find age and gender predictive of readmission rates consistent with previous evidence.[13][18][23][28][29]

Although the rates of cardiogenic shock and mechanical ventilation were significantly higher with index admission, the mortality rate was slightly higher in readmitted patients (8.12% vs. 7.28%, p=0.05). The underlying severity of HF and ejection fraction might drive this, and although rates were adjusted with the Charlson comorbidity index, HF AF shares similar risk factors, which increases the chance of unmeasured confounders. Nevertheless, these findings emphasize the importance of preventing readmission. Length of stay and hospitalization charges are comparable to index admission (6.1 vs. 6.4 days, p<0.001) ($61,693 vs. $65,741, p=0.01). Total preventable days of hospitalization were 45,706 for 2018, which translates to a $461 million financial burden.

Subgroup analysis showed that the mortality rate was higher in HFpEF (6.47% vs. 8.88%), while in HFrEF, mortality did not differ. The difference in mortality in HFpEF is likely due to unmeasured confounders such as degree of kidney dysfunction or sepsis, which were among the top 3 causes of readmission. Further studies are warranted if medications with mortality benefit or ablation for AF had an impact on mortality during readmission in patients with HFrEF and AF.

As with any cross-sectional study, we cannot establish causality but only associations. Our study is based on a database based on ICD-10 CM coding, which can include possible coding errors/risk factors or diagnoses not entered into the database. We did not distinguish between different types of AF and lacked information on race, type of antiarrhythmics drugs used, laboratory data, imaging findings, baseline vital signs and if has had any outpatient ablation procedures for AF. We could not evaluate social barriers for discharge or readmission, outpatient resource accessibility, and medication compliance. NRD does not record out-of-state readmissions.

In conclusion, the 30-day readmission rate was 16.7% in HF patients with concurrent AF. Readmitted patients had a higher mortality rate when compared to the index admission. Low

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socioeconomic status, comorbidities, Medicare and Medicaid insurance, are independent predictors for 30-day readmission. Financial burden incurred from readmission was $461 million for the year 2018. Future studies directed with interventions to prevents readmissions are warranted.

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