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Outcomes of Medicare Beneficiaries With Heart Failure and Atrial Fibrillation

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Objectives This study sought to examine the long-term outcomes of patients hospitalized with heart failure and atrial fibrillation.

Background Atrial fibrillation is common among patients hospitalized with heart failure. Associations of pre-existing and new-onset atrial fibrillation with long-term outcomes are unclear.

Methods We analyzed 27,829 heart failure admissions between 2006 and 2008 at 281 hospitals in the American Heart Association's Get With The Guidelines–Heart Failure program linked with Medicare claims. Patients were classified as having pre-existing, new-onset, or no atrial fibrillation. Cox proportional hazards models were used to identify factors that were independently associated with all-cause mortality, all-cause readmission, and readmission for heart failure, stroke, and other cardiovascular disease at 1 and 3 years.

Results After multivariable adjustment, pre-existing atrial fibrillation was associated with greater 3-year risks of all-cause mortality (hazard ratio [HR]: 1.14 [99% confidence interval (CI): 1.08 to 1.20]), all-cause readmission (HR: 1.09 [99% CI: 1.05 to 1.14]), heart failure readmission (HR: 1.15 [99% CI: 1.08 to 1.21]), and stroke readmission (HR: 1.20 [99% CI: 1.01 to 1.41]), compared with no atrial fibrillation. There was also a greater hazard of mortality at 1 year among patients with new-onset atrial fibrillation (HR: 1.12 [99% CI: 1.01 to 1.24]). Compared with no atrial fibrillation, new-onset atrial fibrillation was not associated with a greater risk of the readmission outcomes. Stroke readmission rates at 1 year were just as high for patients with preserved ejection fraction as for patients with reduced ejection fraction.

Conclusions Both pre-existing and new-onset atrial fibrillation were associated with greater long-term mortality among older patients with heart failure. Pre-existing atrial fibrillation was associated with greater risk of readmission. (J Am Coll Cardiol HF 2014;2:41–8) © 2014 by the American College of Cardiology Foundation

Although atrial fibrillation (AF) is common among patients hospitalized with heart failure (HF), it is unclear whether pre-existing and new-onset AF confer similar risks. In-hospital mortality and length of stay are greater among patients with HF and AF (1); however, long-term prognosis is less clear. In some studies, concurrent HF and AF were associated with higher rates of all-cause mortality and other cardiovascular events (2–4). Other studies have shown no

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Abbreviations and Acronyms

AF = atrial fibrillation

EF = ejection fraction

HF = heart failure

higher risk of adverse outcomes (5–7). Conflicting outcomes in patients with HF and AF may reflect prognostic differences between pre-existing and new-onset AF or differences between HF with preserved ejection fraction (EF) and AF.

To clarify the long-term prognosis of patients with HF and pre-existing or new-onset AF, and AF-associated risk in patients with HF with reduced or preserved EF, we examined long-term outcomes of patients hospitalized with HF and AF in a clinical registry linked with Medicare claims.

Methods

Data sources. Data were from the American Heart Association's Get With The Guidelines–Heart Failure registry and Medicare claims. As described previously (8,9), the voluntary hospital-based registry includes patients with HF as the primary cause of admission or patients who developed significant HF symptoms during the hospitalization. Outcome Sciences, Inc., is the data collection coordination center for the American Heart Association/American Stroke Association Get With The Guidelines programs.

The Medicare data consisted of research-identifiable inpatient files and corresponding denominator files for 2006 through 2008. The inpatient files contain institutional claims for facility costs covered under Medicare Part A and include beneficiary, physician, and hospital identifiers; admission and discharge dates; and diagnosis and procedure codes. The denominator files include dates of birth, sex, race/ethnicity, dates of death, and information about program eligibility and enrollment. We linked registry data to claims data by using the method described by Hammill et al. (10).

Study population. We identified Medicare beneficiaries who were ≥65 years of age, were discharged from a registry hospitalization between January 1, 2006, and December 31, 2008, and were enrollees in fee-for-service Medicare at discharge. We restricted the initial dataset to patients who had a history of HF and who required documentation in the registry (at least 1 admission vital sign, presence or absence of medical history of AF, and presence or absence of a diagnosis of AF at presentation or upon hospitalization), were discharged alive, did not leave against medical advice, and were not transferred to another short-term hospital or to hospice. For patients with multiple hospitalizations in the registry, we selected the first instance as the index hospitalization. The population was stratified according to AF status as documented in the registry: no AF (no medical history of AF or diagnosis of AF at presentation or during hospitalization), new-onset AF (diagnosis at presentation or during hospitalization and no pre-existing AF), or pre-existing AF (International Classification of Diseases-Ninth Revision-Clinical Modification, diagnosis code 427.31 in any position on an inpatient claim or ≥2 outpatient or carrier claims in the year before the study period). This approach has 94% sensitivity, 99% specificity, and 97% positive predictive value for identifying new-onset AF in administrative data (11).

Outcomes. The outcomes of interest were all-cause mortality and readmission for any cause, HF, stroke, and other cardiovascular reasons at 1 and 3 years. We identified deaths on the basis of death dates in the Medicare mortality files. Readmission was defined on the basis of any new nonelective inpatient claim, not including the index hospitalization claim, transfers to or from another hospital, and admissions for rehabilitation. Table 1 presents the codes used to identify outcomes in the claims. HF readmissions were readmissions with a primary diagnosis of HF. Stroke readmissions were those with a primary diagnosis of subarachnoid hemorrhage, intracerebral hemorrhage, ischemic stroke, or transient ischemic attack. Other cardiovascular readmissions were those with a diagnosis-related group of cardiovascular causes that did not also meet the criteria for a stroke or HF readmission and were not for a primary diagnosis of AF. In previous analyses, the positive predictive values for these outcomes were 97% for HF, 96% for stroke, and almost 100% for death and all-cause readmission (12,13).

The index hospitalization discharge dates were identified from the registry. We analyzed outcomes by using survival methods (time-to-event) and calculated days to death and first readmission. For patients who did not experience a particular outcome, we defined a censoring date as 1 or 3 years after discharge (depending on the outcome), the end of Medicare claims data availability, or the date the patient enrolled in a Medicare managed care plan, whichever occurred first. Death was treated as a competing risk for the readmission outcomes.

Covariates. Baseline covariates included demographic characteristics, vital signs, medical history, comorbid conditions, and medical tests at admission from the registry. Demographic characteristics included age, sex, and race. Vital signs at admission included systolic blood pressure, respiratory rate, and heart rate. Tests at admission included blood urea nitrogen, serum creatinine, left ventricular EF, and serum sodium. Renal function was assessed by using the Modification of Diet in Renal Disease formula for estimated glomerular filtration rate (14). From the registry, we identified medical history of anemia, implantable cardioverter-defibrillator use, chronic obstructive pulmonary disease, depression, diabetes mellitus, hyperlipidemia, hypertension, ischemic etiology of HF, pacemaker use, peripheral vascular disease, cerebrovascular accident or transient ischemic attack, renal insufficiency, and being a smoker in the past year. From the Medicare claims data, we identified comorbid conditions on the basis of Hierarchical Condition Category codes on the index hospitalization claim (Table 1). Comorbid conditions included protein-calorie malnutrition, dementia, major psychiatric disorders, and chronic liver disease. These variables have independent prognostic value for modeling all-cause hospital readmission and mortality after hospitalization for HF (15,16).

Table 1 Codes for Outcomes and Comorbid Conditions Used in the Analysis

	ICD-9-CM Diagnosis Codes	Diagnosis-Related Groups	Hierarchical Condition Categories
Outcome			
Atrial fibrillation	427.31		
Heart failure	428.x, 402.x1, 404.x1, or 404.x3		
Stroke or transient ischemic attack			
Subarachnoid hemorrhage	430.x		
Intracerebral hemorrhage	431.x		
Ischemic stroke	433.x1, 434.x1, or 436		
Transient ischemic attack	435.x		
Readmission			
Cardiovascular causes		104–112, 115–118, 121–145, 479, 514–518, 525–527, 535, 536, and 547–558 (before October 1, 2007); 215–238, 242–254, 258–262, 280–316 (on or after October 1, 2007)	
Covariates			
Comorbid conditions			
Protein-calorie malnutrition			21
Dementia			49–50
Disability			100, 101, 102, 68, 69, 177, and 178
Major psychiatric disorders			54, 55, and 56
Chronic liver disease			25, 26, and 27

ICD-9-CM = International Classification of Diseases-Ninth Revision-Clinical Modification.

Subgroups. The subgroups of interest were patients with preserved EF and patients with reduced EF (determined from the registry). Reduced EF included the following: 1) quantitative EF <40%; 2) moderate or severe qualitative left ventricular systolic dysfunction; or 3) documented left ventricular systolic dysfunction. Preserved EF was EF ≥40% and an absence of moderate or severe qualitative left ventricular systolic dysfunction or documented left ventricular systolic dysfunction.

Statistical analysis. Baseline characteristics of the study population were described by using frequencies, with percentages for categorical variables and medians with interquartile ranges for continuous variables. We used chi-square tests and Wilcoxon rank sum tests for differences in categorical variables and continuous variables, respectively. Kaplan-Meier methods were used to estimate unadjusted mortality and HF readmission rates at 1 and 3 years stratified according to AF status. We included a single variable with 3 levels of AF status (none, pre-existing, and new-onset) and conducted pairwise comparisons to test for differences between patients with pre-existing AF and no AF and between patients with new-onset AF and no AF. Differences in mortality were tested for by using log-rank tests. Unadjusted readmission rates at 1 and 3 years were estimated by using the cumulative incidence function, which accounts for the competing risk of mortality (17). We tested for differences in the readmission outcomes by using Gray tests (18). Finally, we estimated multivariable relationships between patient characteristics and each outcome of interest by using Cox proportional hazards models. If a variable had <5% missing values, the missing value was replaced with the median value for continuous variables and with the dominant category for categorical variables (19). If a variable had >5% missing values, the missing values were treated as a separate category; therefore, missing data for these variables could be included in the analysis.

For subgroup analyses, stroke readmission rates were estimated according to HF subgroup (i.e., preserved and reduced EF) and AF status (i.e., pre-existing and new-onset). We tested the differences between HF subgroups by using Gray tests. A Cox proportional hazards model was used to examine whether associations between HF subgroup and stroke readmission differed according to AF status. Specifically, in addition to demographic characteristics, medical history, and other clinical factors, we included an interaction between HF subgroup and AF status.

Because of the number of comparisons in the analysis, we report 99% confidence intervals and used alpha = 0.01 to establish statistical significance. All p values are based on 2-sided tests. R version 2.6 (R Foundation for Statistical Computing, Vienna, Austria) was used for the cumulative incidence analyses; for all other analyses, SAS version 9.2 (SAS Institute, Inc., Cary, North Carolina) was used. The institutional review board of the Duke University Health System approved the study.

Results

Among 27,829 patients admitted for HF at 281 hospitals, 9,509 (34.2%) had pre-existing AF, 2,026 (7.3%) had new-onset AF, and 16,294 (58.5%) had no AF (Table 2). Patients with pre-existing AF were more likely to have a history of stroke or transient ischemic attack (17.3% vs. 14.5% for patients with no AF), but this difference was not

Table 2 Baseline Characteristics of the Study Population According to Atrial Fibrillation Status at Hospital Admission

	Atrial Fibrillation Status				
	None (n = 16,294)	Pre-Existing (n = 9,509)	p Value*	New-Onset (n = 2,026)	p Value†
Age, yrs	79 (72–85)	81 (75–87)	<0.001	81 (75–87)	<0.001
Age group, yrs					
65–79	8,410 (51.6)	3,875 (40.8)	<0.001	858 (42.4)	<0.001
≥80	7,884 (48.4)	5,634 (59.3)		1,168 (57.7)	
Sex			<0.001		0.13
Female	9,084 (55.7)	4,997 (52.6)		1,094 (54.0)	
Male	7,210 (44.3)	4,512 (47.5)		932 (46.0)	
Race			<0.001		<0.001
Black	2,317 (14.2)	642 (6.8)		137 (6.8)	
White	12,307 (75.5)	8,258 (86.8)		1,684 (83.1)	
Other/unknown	1,670 (10.2)	609 (6.4)		205 (10.1)	
Medical history					
Anemia	2,867 (17.6)	1,795 (18.9)	0.01	260 (12.8)	<0.001
COPD	4,422 (27.1)	2,707 (28.5)	0.02	487 (24.0)	0.003
Cerebrovascular accident/TIA	2,356 (14.5)	1,646 (17.3)	<0.001	265 (13.1)	0.09
Depression	1,588 (9.8)	955 (10.0)	0.44	154 (7.6)	0.002
Diabetes mellitus	6,747 (41.4)	3,277 (34.5)	<0.001	646 (31.9)	<0.001
Hypertension	12,243 (75.1)	7,037 (74.0)	0.04	1,369 (67.6)	<0.001
Hyperlipidemia	6,892 (42.3)	3,898 (41.0)	0.04	730 (36.0)	<0.001
Ischemic heart failure etiology	10,206 (62.6)	5,740 (60.4)	<0.001	1,106 (54.6)	<0.001
Pacemaker	1,679 (10.3)	1,689 (17.8)	<0.001	229 (11.3)	0.17
Peripheral vascular disease	2,112 (13.0)	1,258 (13.2)	0.54	185 (9.1)	<0.001
Renal insufficiency	3,066 (18.8)	1,688 (17.8)	0.03	274 (13.5)	<0.001
Smoking in the past year	1,705 (10.5)	632 (6.7)	<0.001	158 (7.8)	<0.001
Comorbid conditions					
Chronic liver disease	147 (0.9)	77 (0.8)	0.44	12 (0.6)	0.16
Dementia	1,183 (7.3)	690 (7.3)	0.99	156 (7.7)	0.47
Disability	344 (2.1)	199 (2.1)	0.92	37 (1.8)	0.40
Malnutrition	396 (2.4)	230 (2.4)	0.95	52 (2.6)	0.71
Psychiatric disorder	201 (1.2)	86 (0.9)	0.02	15 (0.7)	0.05
Vital signs					
Systolic blood pressure (mm Hg)			<0.001		<0.001
<110	1,880 (11.5)	1,432 (15.1)		255 (12.6)	
110–150	8,293 (50.9)	5,399 (56.8)		1,178 (58.1)	
>150	5,963 (36.6)	2,605 (27.4)		570 (28.1)	
Missing	158 (1.0)	73 (0.8)		23 (1.1)	
Respiratory rate (breaths/min)			0.11		0.11
<30	14,534 (89.2)	8,551 (89.9)		1,829 (90.3)	
≥30	1,072 (6.6)	603 (6.3)		131 (6.5)	
Missing	688 (4.2)	355 (3.7)		66 (3.3)	

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observed for patients with new-onset AF. Patients with either pre-existing or new-onset AF were more likely than patients with no AF to have preserved EF (64.0% and 65.4%, respectively, vs. 59.8%).

Compared with patients with no AF, patients with pre-existing or new-onset AF had a higher observed cumulative incidence of all-cause mortality at 1 and 3 years; patients with new-onset AF had a higher mortality at 1 year ($p = 0.001$) and a nonsignificant trend toward higher mortality at 3 years ($p = 0.03$) (Table 3). Patients with pre-existing or new-onset AF had fewer other cardiovascular readmissions at both 1 and 3 years. Stroke readmission rates were similar for patients with pre-existing and new-onset AF compared with no AF at both 1 and 3 years.

After multivariable adjustment, pre-existing AF was associated with a higher risk of all-cause mortality, all-cause readmission, and AF readmission compared with no AF (Table 4). Figure 1 shows the cumulative incidence of all-cause mortality and HF readmission. Pre-existing AF was associated with a higher risk of stroke readmission at 3 years. After multivariable adjustment for significant covariates, the hazard of all-cause mortality among patients with new-onset AF increased modestly, although it was not statistically significant at 3 years ($p = 0.05$). New-onset AF was not associated with

Table 2 Continued

	Atrial Fibrillation Status				
	None (n = 16,294)	Pre-Existing (n = 9,509)	p Value*	New-Onset (n = 2,026)	p Value†
Heart rate (beats/min)			<0.001		<0.001
<80	7,699 (47.3)	4,288 (45.1)		750 (37.0)	
80–100	5,675 (34.8)	3,099 (32.6)		671 (33.1)	
>100	2,353 (14.4)	1,813 (19.1)		568 (28.0)	
Missing	567 (3.5)	309 (3.3)		37 (1.8)	
Test results					
Left ventricular ejection fraction (%)			<0.001		<0.001
<40	6,502 (39.9)	3,410 (35.9)		697 (34.4)	
≥40	9,749 (59.8)	6,083 (64.0)		1,325 (65.4)	
Missing	43 (0.3)	16 (0.2)		4 (0.2)	
Blood urea nitrogen (mg/dl)			0.02		<0.001
<20	4,619 (28.4)	2,573 (27.1)		639 (31.5)	
20–50	8,579 (52.7)	5,202 (54.7)		1,047 (51.7)	
>50	1,813 (11.1)	1,026 (10.8)		176 (8.7)	
Missing	1,283 (7.9)	708 (7.5)		164 (8.1)	
Estimated glomerular filtration rate (ml/min/1.73 m^2)			<0.001		<0.001
<30	3,013 (18.5)	1,386 (14.6)		274 (13.5)	
30–59	7,041 (43.2)	4,489 (47.2)		898 (44.3)	
≥60	4,961 (30.5)	2,915 (30.7)		651 (32.1)	
Missing	1,279 (7.9)	719 (7.6)		203 (10.0)	
Serum sodium (mEq)			0.32		0.34
<135	2,684 (16.5)	1,628 (17.1)		361 (17.8)	
135–145	11,642 (71.5)	6,779 (71.3)		1,434 (70.8)	
>145	293 (1.8)	177 (1.9)		30 (1.5)	
Missing	1,675 (10.3)	925 (9.7)		201 (9.9)	

Values are median (interquartile range) or n (%). *For the comparison between patients with no atrial fibrillation and patients with pre-existing atrial fibrillation. †For the comparison between patients with no atrial fibrillation and patients with new-onset atrial fibrillation.

COPD = chronic obstructive pulmonary disease; TIA = transient ischemic attack.

higher risks of all-cause readmission, HF readmission, stroke readmission, or other cardiovascular readmission.

The percentage of patients who had HF with reduced EF was 35.9% among patients with pre-existing AF and 34.4% among patients with new-onset AF. Among patients with pre-existing or new-onset AF, unadjusted 3-year stroke readmission rates were higher among patients with preserved EF than among patients with reduced EF despite similar

Table 3 Observed Cumulative Incidence of Mortality and Readmission According to Atrial Fibrillation Status at Hospital Admission (N = 27,829)

	Atrial Fibrillation Status				
	None (n = 16,294)	Pre-Existing (n = 9,509)	p Value*	New-Onset (n = 2,026)	p Value†
Cumulative incidence at 1 yr					
Mortality	4,788 (30.1)	3,392 (36.4)	<0.001	663 (33.5)	0.001
All-cause readmission	9,900 (61.8)	5,892 (62.9)	0.02	1,187 (59.7)	0.23
Heart failure readmission	4,375 (27.4)	2,668 (28.5)	0.04	513 (25.8)	0.21
Stroke readmission	447 (2.8)	288 (3.1)	0.20	63 (3.2)	0.33
Other cardiovascular readmission	3,020 (19.0)	1,443 (15.5)	<0.001	306 (15.4)	<0.001
Cumulative incidence at 3 yrs					
Mortality	7,707 (56.7)	5,156 (63.4)	<0.001	1,000 (57.9)	0.03
All-cause readmission	11,919 (79.0)	7,032 (79.3)	0.06	1,442 (76.5)	0.12
Heart failure readmission	5,750 (39.3)	3,476 (40.4)	0.05	665 (36.5)	0.05
Stroke readmission	766 (5.7)	481 (6.0)	0.22	112 (6.7)	0.11
Other cardiovascular readmission	4,343 (30.4)	2,098 (25.1)	<0.001	441 (24.9)	<0.001

Values are presented as number of events (cumulative incidence per 100 patients). *For the comparison between patients with no atrial fibrillation and patients with pre-existing atrial fibrillation. †For the comparison between patients with no atrial fibrillation and patients with new-onset atrial fibrillation.

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Table 4 Associations Between Pre-Existing or New-Onset Atrial Fibrillation and Mortality and Readmission After Adjustment for Baseline Characteristics

Outcome	Pre-existing Atrial Fibrillation		New-Onset Atrial Fibrillation	
	Adjusted HR (99% CI)	p Value	Adjusted HR (99% CI)	p Value
Outcomes at 1 yr				
Mortality	1.15 (1.08–1.22)	<0.001	1.12 (1.01–1.24)	0.005
All-cause readmission	1.08 (1.03–1.13)	<0.001	1.05 (0.96–1.16)	0.15
Heart failure readmission	1.13 (1.06–1.21)	<0.001	1.08 (0.95–1.23)	0.11
Stroke readmission	1.17 (0.95–1.44)	0.05	1.19 (0.84–1.68)	0.19
Other cardiovascular readmission	0.89 (0.81–0.98)	0.002	0.92 (0.79–1.07)	0.15
Outcomes at 3 yrs				
Mortality	1.14 (1.08–1.20)	<0.001	1.08 (0.98–1.18)	0.05
All-cause readmission	1.09 (1.05–1.14)	<0.001	1.06 (0.97–1.15)	0.08
Heart failure readmission	1.15 (1.08–1.21)	<0.001	1.07 (0.95–1.20)	0.16
Stroke readmission	1.20 (1.01–1.41)	0.005	1.27 (0.98–1.64)	0.02
Other cardiovascular readmission	0.91 (0.85–0.99)	0.003	0.92 (0.81–1.05)	0.09

The reference group was the cohort of patients with no atrial fibrillation. The multivariable models adjusted for all variables listed in Table 1.
CI = confidence interval; HR = hazard ratio.

rates of oral anticoagulation therapy (53% vs. 57%, respectively) (Table 5). There was an interaction between EF and AF for stroke readmission. After multivariable adjustment, the risk of stroke readmission at 1 year was similar for HF with preserved EF and HF with reduced EF. The risk of stroke readmission for new-onset AF at 3 years was lower with reduced EF than with preserved EF (hazard ratio: 0.56 [99% confidence interval: 0.32 to 0.98]; p = 0.008).

Discussion

Our analysis of long-term outcomes of >27,000 patients hospitalized with HF and AF had several important findings. First, AF was common and was associated with worse outcomes. Patients with AF had higher mortality, and patients with pre-existing AF had higher rates of readmission, including readmission for HF. Finally, the risk of stroke was as high in patients with preserved EF as in those with reduced EF.

A previous analysis of short-term outcomes in the registry showed that AF was independently associated with higher mortality (1). Our study extends these observations. Patients with HF and AF had worse long-term outcomes than patients with HF alone. These data also suggest that outcomes are similarly poor for patients with new-onset AF. Although this finding is not novel, observational data continue to show that new-onset AF is undertreated compared with pre-existing AF (17,18). Patients with new-onset AF are less likely to be treated with stroke prevention therapies regardless of stroke risk (20,21).

To our knowledge, the present study is the first to report cause-specific readmission rates among patients with HF and AF. Pre-existing AF was associated with higher rates of readmission for all causes, HF, and stroke. Higher rates of readmission in patients with pre-existing versus new-onset AF likely reflects the cumulative risks of AF and subsequent adverse events. Consistent with findings from clinical trials (4,22), the risk of myocardial infarction in patients with HF and AF was low. Future studies should examine factors associated with cause-specific readmission to target potential interventions to reduce morbidity.

The risk of stroke in patients with HF and preserved EF and AF has not been thoroughly studied, and most recommendations for anticoagulation therapy in this population are based on expert consensus and small observational studies. Current guidelines recommend oral anticoagulation therapy for all patients with HF and AF (23). Post-hoc analyses of the AFFIRM (Atrial Fibrillation Follow-up Investigation of Rhythm Management) study and the ROCKET-AF (Rivaroxaban Versus Warfarin in Nonvalvular Atrial Fibrillation) study found that patients with concomitant AF and preserved or reduced EF had similar rates of stroke, whereas an analysis of the ARISTOTLE (Apixaban for the Prevention of Stroke in Subjects with Atrial Fibrillation) study found that patients with reduced EF had higher rates of stroke (24–26). Given the limited data, equipoise remains with regard to whether HF with preserved EF should be considered a moderate risk factor for stroke and be considered as part of the "C" in the $CHADS_2$ (congestive heart failure, hypertension, age 75 years, diabetes mellitus, stroke) score. We found that patients with preserved and reduced EF had similar risk for stroke readmission after adjustment. These data suggest that patients with HF and AF should be treated with stroke prophylaxis regardless of EF. Our analyses were restricted to patients with a previous diagnosis of HF because patients with AF and rapid rates who develop new-onset HF theoretically have a different risk profile for stroke. We recognize that the stroke rate in the population without AF was higher than would be expected in a sinus rhythm population, but these higher rates may reflect other causes of stroke.

Study limitations. First, the data were derived from a clinical registry linked with Medicare claims data, and our patient population was older than the average HF population. It is uncertain whether the outcome-specific event rates and

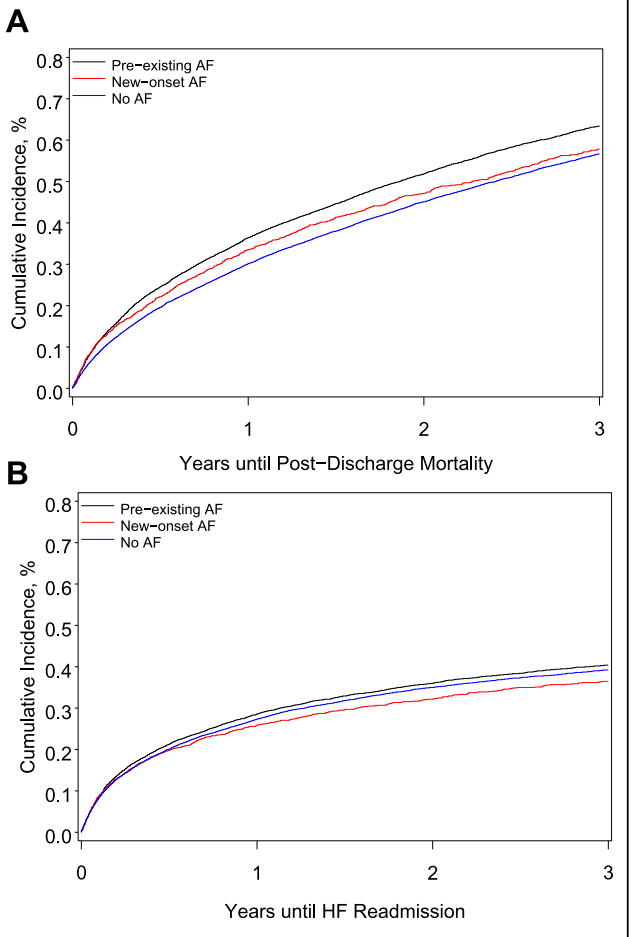

Figure 1 **Cumulative Incidence of All-Cause Death and Heart Failure Readmission According to AF Status**

(A) Cumulative incidence of all-cause death among patients with pre-existing atrial fibrillation (AF), patients with new-onset AF, and patients with no AF. **(B)** Cumulative incidence of readmission for heart failure among patients with pre-existing AF, patients with new-onset AF, and patients with no AF.

hazards are generalizable. However, characteristics and outcomes of Medicare beneficiaries in previous HF registries were similar to the broader Medicare population with HF, suggesting that findings from these registries are generalizable (27,28). Second, we assumed that the coding was accurate for pre-existing and new-onset AF in the registry and for reasons for hospitalization in the Medicare data. The diagnosis of AF was not through electrographic confirmation. It is possible that errors in coding affected the analysis, but previous work suggests that the coding algorithms we used have high specificity (29,30). Third, data regarding medications taken after discharge and adherence to those medications were not available. Fourth, because we accessed an inpatient registry, we did not have outpatient data, such as New York Heart Association classification, and could not account for these factors in our analysis. Lastly, as with any retrospective analysis, unmeasured covariates likely influenced the outcomes.

Table 5 **Unadjusted Cumulative Incidence and Adjusted Hazards of Stroke Readmission in Patients With Pre-Existing or New-Onset Atrial Fibrillation and Heart Failure With Either Preserved or Reduced EF**

	Pre-Existing Atrial Fibrillation					New-Onset Atrial Fibrillation				
	Cumulative Incidence			Adjusted Risk		Cumulative Incidence			Adjusted Risk	
	Reduced EF (n = 3,410)	Preserved EF (n = 6,099)	p Value	HR (99% CI)	p Value	Reduced EF (n = 697)	Preserved EF (n = 1,329)	p Value	HR (99% CI)	p Value
1 yr	15 (2.2)	48 (3.7)	0.08	0.91 (0.63–1.30)	0.48	86 (2.6)	202 (3.4)	0.03	0.67 (0.32–1.37)	0.15
3 yrs	23 (3.7)	89 (8.2)	0.002	0.87 (0.66–1.16)	0.22	142 (5.0)	339 (6.5)	0.005	0.56 (0.32–0.98)	0.008

Values are presented as number of events (cumulative incidence per 100 patients). Rates of oral anticoagulation were 53% for heart failure with preserved ejection fraction and 57% for heart failure with reduced ejection fraction.
EF = ejection fraction; other abbreviations as in Table 4.

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Conclusions

In this nationwide cohort of >27,000 patients with both HF and AF, patients with pre-existing and new-onset AF had higher mortality rates than patients with no AF. Moreover, pre-existing AF was associated with a higher risk of all-cause and HF readmission rates. Whether AF is a marker of deterioration of HF or a mediator of adverse outcomes requires further study. The risk of stroke among patients with HF and AF is high, even among those with preserved EF. Given the morbidity, mortality, and economic burden associated with HF and AF, better treatment options and prevention measures are needed.

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Key Words: atrial fibrillation ■ heart failure ■ Medicare ■ mortality ■ outcome assessment (health care) ■ patient readmission.