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Heart Rate and Outcomes in Hospitalized Patients With Heart Failure With Preserved Ejection Fraction

Phillip H. Lam, MD,[a,b,c] Daniel J. Dooley, MD,[a,b,c] Prakash Deedwania, MD,[a,d] Steven N. Singh, MD,[b,e] Deepak L. Bhatt, MD, MPH,[f,g] Charity J. Morgan, PhD,[h] Javed Butler, MD, MPH, MBA,[i] Selma F. Mohammed, MD, PhD,[c] Wen-Chih Wu, MD,[j,k] Gurusher Panjrath, MD,[l] Michael R. Zile, MD,[m,n] Michel White, MD,[o] Cherinne Arundel, MD,[b,l,p] Thomas E. Love, PhD,[q] Marc R. Blackman, MD,[a,b,l] Richard M. Allman, MD,[r] Wilbert S. Aronow, MD,[s,t] Stefan D. Anker, MD, PhD,[u,v] Gregg C. Fonarow, MD,[w] Ali Ahmed, MD, MPH[a,l,x]

ABSTRACT

BACKGROUND A lower heart rate is associated with better outcomes in patients with heart failure (HF) with reduced ejection fraction (EF). Less is known about this association in patients with HF with preserved ejection fraction (HFpEF).

OBJECTIVES The aims of this study were to examine associations of discharge heart rate with outcomes in hospitalized patients with HFpEF.

METHODS Of the 8,873 hospitalized patients with HFpEF (EF ≥50%) in the Medicare-linked OPTIMIZE-HF (Organized Program to Initiate Lifesaving Treatment in Hospitalized Patients with Heart Failure) registry, 6,286 had a stable heart rate, defined as ≤20 beats/min variation between admission and discharge. Of these, 2,369 (38%) had a discharge heart rate of <70 beats/min. Propensity scores for discharge heart rate <70 beats/min, estimated for each of the 6,286 patients, were used to assemble a cohort of 2,031 pairs of patients with heart rate <70 versus ≥70 beats/min, balanced on 58 baseline characteristics.

RESULTS The 4,062 matched patients had a mean age of 79 ± 10 years, 66% were women, and 10% were African American. During 6 years (median 2.8 years) of follow-up, all-cause mortality was 65% versus 70% for matched patients with a discharge heart rate <70 versus ≥70 beats/min, respectively (hazard ratio [HR]: 0.86; 95% confidence interval [CI]: 0.80 to 0.93; $p < 0.001$). A heart rate <70 beats/min was also associated with a lower risk for the combined endpoint of HF readmission or all-cause mortality (HR: 0.90; 95% CI: 0.84 to 0.96; $p = 0.002$), but not with HF readmission (HR: 0.93; 95% CI: 0.85 to 1.01) or all-cause readmission (HR: 1.01; 95% CI: 0.95 to 1.08). Similar associations were observed regardless of heart rhythm or receipt of beta-blockers.

CONCLUSIONS Among hospitalized patients with HFpEF, a lower discharge heart rate was independently associated with a lower risk of all-cause mortality, but not readmission. (J Am Coll Cardiol 2017;70:1861–71) Published by Elsevier on behalf of the American College of Cardiology Foundation.

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From the [a]Center for Health and Aging, Veterans Affairs Medical Center, Washington, DC; [b]Department of Medicine, Georgetown University, Washington, DC; [c]Division of Cardiology, MedStar Washington Hospital Center, Washington, DC; [d]Division of Cardiology, Department of Medicine, University of California, San Francisco, Fresno, California; [e]Section of Cardiology, Department of Medicine, Veterans Affairs Medical Center, Washington, DC; [f]Department of Medicine, Brigham and Women's Hospital Heart & Vascular Center, Boston, Massachusetts; [g]Harvard Medical School, Boston, Massachusetts; [h]Department of Biostatistics, School of Public Health, University of Alabama at Birmingham, Birmingham, Alabama; [i]Division of Cardiology, Department of Medicine, Stony Brook University, Stony Brook, New York; [j]Section of Cardiology, Department of Medicine, Veterans Affairs Medical Center, Providence, Rhode Island; [k]Division of Cardiology, Department of Medicine, Brown University, Providence, Rhode Island; [l]Department of Medicine, George Washington University, Washington, DC; [m]Section of Cardiology, Department of Medicine, Ralph H. Johnson VA Medical Center, Charleston, South Carolina; [n]Division of Cardiology, Department of Medicine, Medical University of South Carolina, Charleston, South Carolina; [o]Division of Cardiology, Montreal Heart Institute,

ABBREVIATIONS AND ACRONYMS

CI = confidence interval

EF = ejection fraction

HF = heart failure

HFpEF = heart failure with preserved ejection fraction

HFrEF = heart failure with reduced ejection fraction

HR = hazard ratio

Heart failure (HF) is a leading cause of cardiovascular morbidity and mortality (1). Heart rate has emerged as a powerful independent predictor of outcome in patients with HF with reduced ejection fraction (HFrEF) and therapeutic interventions targeted at lowering heart rate have been shown to improve outcomes in these patients (2–5). However, less is known about the association of heart rate and outcomes in patients with HF with preserved ejection fraction (HFpEF), which constitute nearly one-half of all HF patients (6,7). The objective of the current study was to examine the associations of heart rate with outcomes in patients with HFpEF.

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METHODS

We used data from the OPTIMIZE-HF (Organized Program to Initiate Lifesaving Treatment in Hospitalized Patients with Heart Failure) registry, a national hospital-based registry, the details of which have been previously described (7,8). Briefly, the OPTIMIZE-HF registry is based on 48,612 HF hospitalizations in 259 hospitals in 48 states between March 1, 2003, and December 31, 2004. Charts were selected based on International Classification of Diseases, Ninth Revision codes for principal discharge diagnosis of HF. Extensive data on demographics, patient and hospital characteristics, quality of care, and outcomes were collected using an Internet-based information system. The current analysis was based on 26,376 unique patients in the Medicare-linked OPTIMIZE-HF registry, of whom 8,873 had HFpEF defined as an ejection fraction (EF) ≥50% (7,9).

Admission and discharge heart rates (in beats/min) were estimated by palpation, telemetry, and electrocardiogram for patients with sinus rhythm and atrial fibrillation, as appropriate (8). To minimize bias due to possible measurement errors or acute inpatient clinical instability, we restricted our analysis to patients with stable heart rates, defined as admission to discharge heart rate variation of ≤20 beats/min. Of the 6,286 patients with a stable heart rate, 2,369 (38%) had a discharge heart rate of <70 beats/min (**Figure 1**). We used a heart rate cutoff of 70 beats/min to define low heart rate, given that a heart rate

Department of Medicine, Université de Montréal, Montreal, Quebec, Canada; [p]Hospitalist Section, Medical Service Department, Veterans Affairs Medical Center, Washington, DC; [q]Department of Medicine, Department of Population and Quantitative Health Sciences, and Center for Health Care Research and Policy, Case Western Reserve University, Cleveland, Ohio; [r]Geriatrics and Extended Care, Department of Veterans Affairs, Washington, DC; [s]Division of Cardiology, Department of Medicine, Westchester Medical Center, Valhalla, New York; [t]Division of Cardiology, Department of Medicine, New York Medical College, Valhalla, New York; [u]Division of Cardiology and Metabolism-Heart Failure, Cachexia & Sarcopenia, Department of Cardiology (CVK), Berlin-Brandenburg Center for Regenerative Therapies (BCRT), and Deutsches Zentrum für Herz-Kreislauf-Forschung (German Centre for Cardiovascular Research), Charité-Universitätsmedizin Berlin, Berlin, Germany; [v]Department of Cardiology and Pneumology, University Medicine Göttingen, Göttingen, Germany; [w]Division of Cardiology, Department of Medicine, University of California, Los Angeles, Los Angeles, California; and the [x]Division of Gerontology, Geriatrics, and Palliative Care, Department of Medicine, University of Alabama at Birmingham, Birmingham, Alabama. Dr. Ahmed was supported in part by the National Institutes of Health through grants R01-HL085561, R01-HL085561-S, and R01-HL097047) from the National Heart, Lung, and Blood Institute. Dr. Bhatt has served on the advisory boards of Cardax, Elsevier Practice Update Cardiology, Medscape Cardiology, and Regado Biosciences; has served on the board of directors of the Boston VA Research Institute and the Society of Cardiovascular Patient Care; served as chair of the American Heart Association Quality Oversight Committee; has served on data monitoring committees for the Cleveland Clinic, Duke Clinical Research Institute, Harvard Clinical Research Institute, Mayo Clinic, Mount Sinai School of Medicine, and Population Health Research Institute; has received honoraria from the American College of Cardiology (senior associate editor, Clinical Trials and News, ACC.org), Belvoir Publications (Editor-in-Chief, *Harvard Heart Letter*), Duke Clinical Research Institute (clinical trial steering committees), Harvard Clinical Research Institute (clinical trial steering committee), HMP Communications (Editor-in-Chief, *Journal of Invasive Cardiology*), *Journal of the American College of Cardiology* (guest editor; associate editor), Population Health Research Institute (clinical trial steering committee), Slack Publications (chief medical editor, *Cardiology Today's Intervention*), Society of Cardiovascular Patient Care (secretary/treasurer), and WebMD (CME steering committees); has other relationships with *Clinical Cardiology* (deputy editor), NCDR-ACTION Registry Steering Committee (chair), and VA CART Research and Publications Committee (chair); has received research funding from Amarin, Amgen, AstraZeneca, Bristol-Myers Squibb, Chiesi, Eisai, Ethicon, Forest Laboratories, Ironwood, Ischemix, Lilly, Medtronic, Pfizer, Roche, Sanofi, and The Medicines Company; has received royalties from Elsevier (editor, *Cardiovascular Intervention: A Companion to Braunwald's Heart Disease*); has been a site coinvestigator for Biotronik, Boston Scientific, and St. Jude Medical (now Abbott); has been a trustee for the American College of Cardiology; and has performed unfunded research for FlowCo, Merck, PLx Pharma, and Takeda. Dr. Butler is a consultant to Amgen, AstraZeneca, Bayer, Boehringer Ingelheim, Bristol-Myers Squibb, CVRx, Janssen, Luitpold, Medtronic, Novartis, Relypsa, Roche, Vifor, and ZS Pharma. Dr. Panjrath has been a speaker for Amgen. Dr. Anker has served as a consultant to Servier, Novartis, St. Jude Medical, Bayer, Boehringer Ingelheim, and Vifor. Dr. Fonarow has been a consultant for Amgen, Novartis, Medtronic, and St. Jude Medical; and served as principle investigator for OPTIMIZE-HF, which was sponsored by GlaxoSmithKline. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose. Drs. Lam and Dooley contributed equally to this work.

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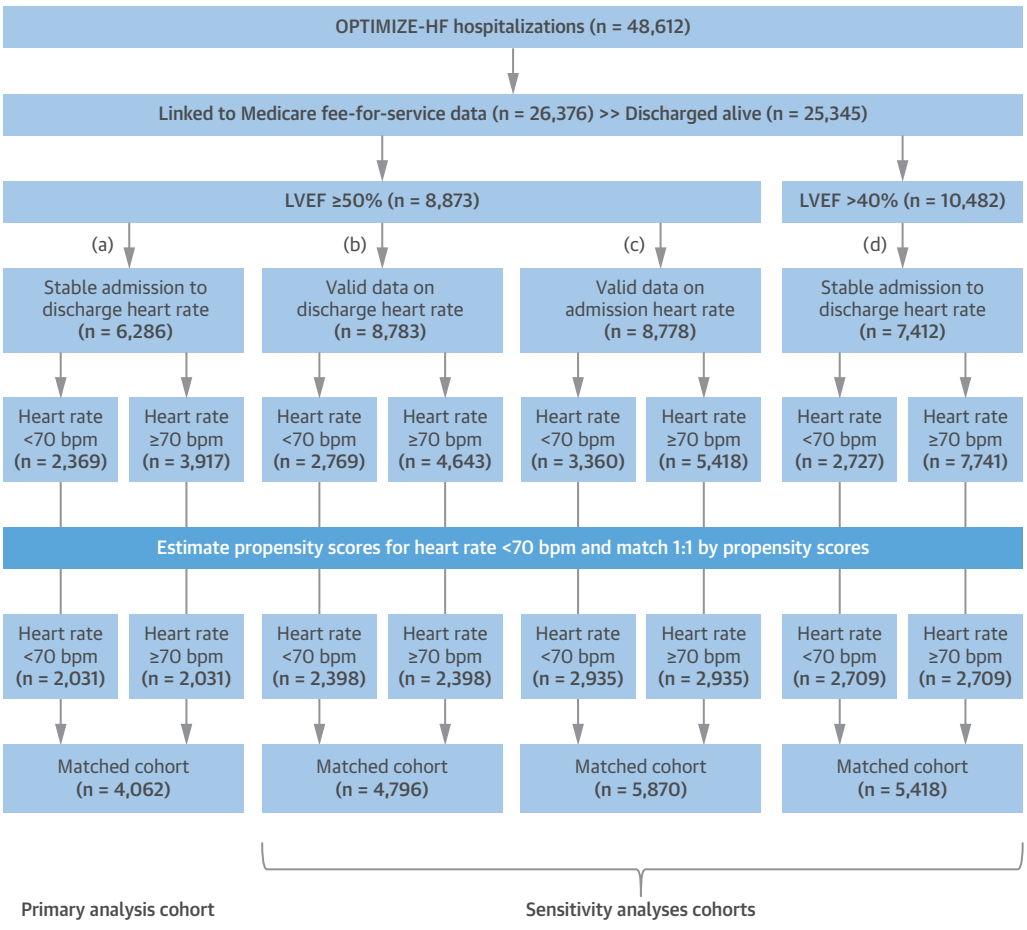
FIGURE 1 Assembly of Study Cohorts



Flow chart displaying assembly of propensity score-matched cohorts of patients with heart failure with preserved ejection fraction, by heart rate <70 versus ≥70 beats/min. bpm = beats/min; LVEF = left ventricular ejection fraction; OPTIMIZE-HF = Organized Program to Initiate Lifesaving Treatment in Hospitalized Patients with Heart Failure.

<70 beats/min has been shown to be associated with improved cardiovascular outcomes in patients with HFrEF (2,3,5).

ASSEMBLY OF COHORTS. We used propensity scores to assemble a matched cohort in which patients with a discharge heart rate <70 versus ≥70 beats/min would be balanced on key measured baseline characteristics (10–12). A multivariable logistic regression model was used to estimate propensity scores for discharge heart rate <70 beats/min for each of the 6,286 patients using 58 baseline characteristics displayed in **Figure 2** (13–16). Using a matching algorithm described elsewhere (17), we matched 2,031 patients with a heart rate <70 beats/min with 2,031 patients with heart rate ≥70 beats/min to assemble a matched cohort of 4,062 patients (**Figure 1A**). Between-group balance for each of the 58 baseline characteristics was assessed using absolute standardized differences, and the results were presented as a Love plot (**Figure 2**) (18).

To determine whether the associations observed in our primary cohort could be replicated using different approaches, we assembled 3 sensitivity cohorts. First, to determine whether the association of discharge heart rate <70 beats/min and outcomes could be replicated without excluding those with an unstable heart rate (admission-to-discharge heart rate variation >20 beats/min), we repeated the process in 8,783 patients with valid data on discharge heart rate,

FIGURE 2 Love Plot for Balance in Baseline Characteristics

This Love plot displays absolute standardized differences comparing 58 baseline characteristics of 6,286 pre-match and 4,062 propensity score-matched patients with heart failure with preserved ejection fraction (≥50%) by heart rate <70 versus ≥70 beats/min. An absolute standardized difference of 0% indicates no residual bias and values <10% indicate inconsequential bias. ACE = angiotensin-converting enzyme; ARB = angiotensin receptor blockers.

assembling 4,796 propensity score-matched patients (2,398 pairs) with discharge heart rate <70 versus ≥70 beats/min (Figure 1B). Then, to determine whether the association could be replicated using admission heart rate <70 beats/min, we repeated the process in 8,778 patients with valid data on admission heart rate regardless of admission-to-discharge heart rate variations, assembling 5,870 matched patients (2,935 pairs) with an admission heart rate <70 versus ≥70 beats/min (Figure 1C). Finally, to determine whether the findings of our primary cohort could be replicated using a different EF cutoff, we repeated the process in 7,412 patients with EF >40% and stable heart rate, assembling 5,418 matched patients (2,709 pairs) with a discharge heart rate <70 versus ≥70 beats/min (Figure 1D).

OUTCOMES DATA. The primary outcome of the current analysis was all-cause mortality during 6 years (median 2.8 years) of follow-up. Secondary outcomes included all-cause readmission, HF readmission, combined endpoints of HF readmission or all-cause mortality, and the combination of all-cause readmission or all-cause mortality. Data on all outcome events and time to events were collected from the Medicare 100% MedPAR File and the 100% Beneficiary Summary File between January 1, 2002 and December 31, 2008 (9).

STATISTICAL ANALYSES. For descriptive analyses, between-group baseline characteristics were compared using the Pearson chi-square and Wilcoxon rank sum tests, as appropriate. All outcome analyses

TABLE 1 Baseline Characteristics

	Before Propensity Score Matching (n = 6,286)			After Propensity Score Matching (n = 4,062)		
	Heart Rate ≥70 Beats/Min (n = 3,917)	Heart Rate <70 Beats/Min (n = 2,369)	p Value	Heart Rate ≥70 Beats/Min (n = 2,031)	Heart Rate <70 Beats/Min (n = 2,031)	p Value
Age, yrs	78 ± 11	79 ± 10	<0.001	79 ± 11	79 ± 10	0.768
Women	2,597 (66)	1,548 (65)	0.438	1,343 (63)	1,327 (65)	0.597
African American	510 (13)	230 (10)	<0.001	209 (10)	217 (11)	0.682
Left ventricular ejection fraction, %	59 ± 7	59 ± 7	0.771	59 ± 7	59 ± 7	0.661
Past medical history						
No known prior heart failure	522 (13)	296 (13)	0.342	257 (13)	246 (12)	0.600
Hypertension	2,960 (76)	1,919 (81)	<0.001	1,621 (80)	1,615 (80)	0.815
Coronary artery disease	1,611 (41)	1,194 (50)	<0.001	983 (48)	972 (48)	0.730
Acute myocardial infarction	582 (15)	408 (17)	0.013	340 (17)	348 (17)	0.738
Coronary revascularization	847 (22)	663 (28)	<0.001	531 (26)	530 (26)	0.972
Diabetes mellitus	1,628 (42)	1,065 (45)	0.008	895 (44)	892 (44)	0.924
Cerebrovascular disease	673 (17)	451 (19)	0.063	380 (19)	379 (19)	0.968
Peripheral vascular disease	533 (14)	403 (17)	<0.001	325 (16)	327 (16)	0.932
Atrial fibrillation	1,341 (34)	759 (32)	0.074	684 (34)	659 (32)	0.404
Chronic obstructive pulmonary disease	1,253 (32)	594 (25)	<0.001	551 (27)	544 (27)	0.805
Admission clinical findings						
Dyspnea at rest	1,687 (43)	958 (40)	0.041	834 (41)	831 (41)	0.924
Dyspnea on exertion	2,450 (63)	1,543 (65)	0.039	1,328 (65)	1,308 (64)	0.511
Orthopnea	978 (25)	636 (27)	0.098	522 (26)	555 (27)	0.241
Paroxysmal nocturnal dyspnea	529 (14)	310 (13)	0.636	252 (12)	269 (13)	0.425
Chest pain	828 (21)	560 (24)	0.021	472 (23)	458 (23)	0.601
Jugular venous pressure elevation	966 (25)	583 (25)	0.963	499 (25)	505 (25)	0.827
Peripheral edema	2,616 (67)	1,598 (68)	0.585	1,364 (67)	1,371 (68)	0.815
Heart rate, beats/min*	83 ± 13	67 ± 9	<0.001	82 ± 10	62 ± 5	<0.001
Discharge clinical findings						
Heart rate, beats/min*	82 ± 10	62 ± 5	<0.001	81 ± 9	62 ± 5	<0.001
Systolic blood pressure, mm Hg	129 ± 21	133 ± 22	<0.001	131 ± 22	132 ± 21	0.949
Diastolic blood pressure, mm Hg	67 ± 12	64 ± 12	<0.001	65 ± 12	65 ± 12	0.669
Serum creatinine, mg/dl	1.7 ± 1.4	1.7 ± 1.2	0.290	1.7 ± 1.2	1.7 ± 1.2	0.688
Discharge medications						
ACE inhibitors or ARBs	2,172 (56)	1,447 (61)	<0.001	1,228 (61)	1,209 (60)	0.543
Beta-blockers	1,987 (51)	1,603 (68)	<0.001	1,309 (65)	1,302 (64)	0.819
Aldosterone antagonists	291 (7)	197 (8)	0.203	159 (8)	160 (8)	0.953
Digoxin	734 (19)	329 (14)	<0.001	316 (16)	309 (15)	0.761
Loop diuretics	3,103 (79)	1,932 (82)	0.025	1,669 (82)	1,652 (81)	0.490
Nitrates	941 (24)	659 (28)	0.001	530 (26)	553 (27)	0.414
Amlodipine	396 (10)	352 (15)	<0.001	258 (13)	272 (13)	0.514
Antiarrhythmic drugs	335 (9)	299 (13)	<0.001	214 (11)	213 (11)	0.959
Warfarin	996 (25)	516 (22)	0.001	487 (24)	466 (23)	0.437
Aspirin	1,653 (42)	1,167 (49)	<0.001	973 (48)	976 (48)	0.925
Statins	1,133 (29)	885 (37)	<0.001	709 (35)	703 (35)	0.843
Hospital length of stay, days	6 ± 5	5 ± 4	<0.001	5 ± 4	5 ± 4	0.112
Hospital characteristics						
Bed size, n	394 ± 240	390 ± 236	0.556	390 ± 239	389 ± 234	0.861
Academic center	1,694 (43)	990 (42)	0.258	851 (42)	862 (42)	0.727
Transplant center	606 (16)	321 (14)	0.037	272 (13)	290 (14)	0.413
Interventional center	3,014 (77)	1,834 (77)	0.667	1,569 (77)	1,558 (77)	0.682

Values are mean ± SD or n (%). *Heart rate is the exposure variable and would not be expected to be balanced in the matched cohort; presented for descriptive purposes only.
ACE = angiotensin-converting enzyme; ARB = angiotensin receptor blocker.

TABLE 2 Outcomes in Propensity Score-Matched Patients

	Events			
	Heart Rate ≥70 Beats/Min (n = 2,031)	Heart Rate <70 Beats/Min (n = 2,031)	Hazard Ratio (95% CI)	p Value
All-cause mortality	70 (1,422)	65 (1,317)	0.86 (0.80–0.93)	<0.001
All-cause readmission	89 (1,810)	90 (1,830)	1.01 (0.95–1.08)	0.681
Heart failure readmission	48 (966)	47 (956)	0.93 (0.85–1.02)	0.111
All-cause readmission or all-cause mortality	97 (1,964)	97 (1,968)	1.01 (0.94–1.07)	0.880
Heart failure readmission or all-cause mortality	84 (1,702)	80 (1,632)	0.90 (0.84–0.96)	0.002

Values are % (n) unless otherwise indicated.
CI = confidence interval.

were conducted using matched data. Kaplan-Meier survival analysis was used to generate plots for all-cause mortality by discharge heart rate (<70 vs. ≥70 beats/min). Cox regression models were used to estimate hazard ratios (HRs) and 95% confidence intervals (CIs) associated with heart rate and survival time (time to event). For mortality, we used time to death for patients who died and time to study end as censoring time for those who did not die. For readmissions, we used time to readmission for patients who had a readmission, and time to death or time to study end, whichever occurred first, as censoring time for those without a readmission. We also fit Fine and Gray's proportional subdistribution hazards models to examine the association of heart rate (<70 vs. ≥70 beats/min) with all-cause readmission in the presence of the competing risk of mortality (19,20). To assess nonlinearity in the relationship between discharge heart rate as a continuous variable and all-cause mortality, we fitted restricted cubic spline models with 3 knots at heart rates of 60, 70 (reference), and 100 beats/min in the pre-match data, adjusting for propensity scores, as well as in the matched data. Formal sensitivity analyses were conducted to quantify the degree of a hidden bias that could potentially explain away any significant association in our primary matched cohort (21,22). Subgroup analyses were conducted to determine the homogeneity of the association of discharge heart rate <70 beats/min and all-cause mortality in our primary matched cohort. All statistical tests were 2-tailed, and a p value <0.05 was considered significant. All statistical analyses were conducted using IBM SPSS Statistics for Windows software, version 24 (IBM, Armonk, New York), except for formal sensitivity and restricted cubic spline model analyses, for which SAS software, version 9.4 for Windows (SAS Institute, Cary, North Carolina) was used.

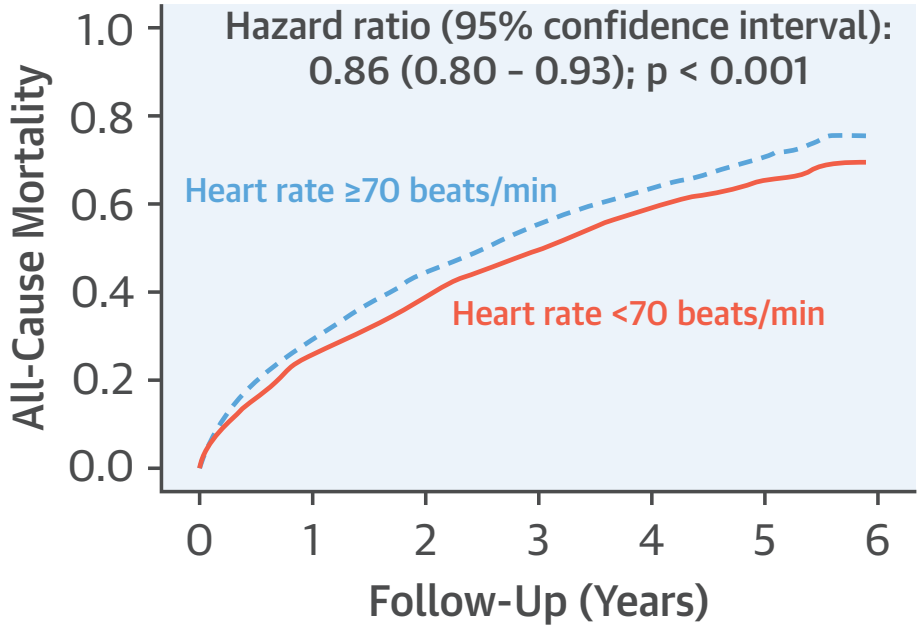
RESULTS

The 4,062 matched patients had a mean age of 79 ± 10 years, EF of 59 ± 7%, and discharge heart rate of 71 ± 12 beats/min; 66% were women, and 10% African American. Of these, 3,455 patients (85%) had a normal discharge heart rate (60 to 100 beats/min), 1,343 (33%) had a history of atrial fibrillation, and 2,611 (64%) received a discharge prescription for beta-blockers. Before matching, patients with a discharge heart rate <70 beats/min had a higher mean age, and a greater proportion of these patients were white and had hypertension, coronary artery disease, and diabetes (Table 1). These and other measured baseline characteristics were balanced after matching, and the absolute standardized difference for all 58 baseline characteristics was <10%, suggesting no consequential between-group differences (Table 1, Figure 2). Mean admission and discharge heart rates for the 2 heart rate groups, before and after matching, are displayed in Table 1.

DISCHARGE HEART RATE AND ALL-CAUSE MORTALITY. During 6 years (median 2.8 years) of follow-up, among the 4,062 matched patients, all-cause mortality occurred in 65% and 70% of those with a discharge heart rate <70 beats/min versus ≥70 beats/min, respectively (HR: 0.86; 95% CI: 0.80 to 0.93; p < 0.001) (Table 2, Central Illustration). In the absence of hidden bias, a sign-score test for matched data with censoring provided strong evidence that patients with a discharge heart rate <70 beats/min outlived those with a heart rate ≥70 beats/min (p < 0.001). Findings of our subgroup analyses demonstrated that the beneficial association between heart rate <70 beats/min and all-cause mortality was homogenous across various clinically relevant subgroups of patients, including those by baseline atrial fibrillation and beta-blocker use (Figure 3). Findings from our restricted cubic spline analysis demonstrated no evidence of a nonlinear relationship between heart rate and all-cause mortality (p > 0.2 for test for nonlinearity in both pre-match and matched data) and that the risk was significantly lower at heart rate <70 beats/min and was significantly higher at heart rate ≥70 beats/min (Figure 4).

Among the 4,796 matched patients with EF ≥50% with a valid discharge heart rate that included patients with unstable inpatient heart rate, all-cause mortality occurred in 66% and 70% of patients with a discharge heart rate <70 beats/min versus

CENTRAL ILLUSTRATION **Kaplan-Meier Plots for All-Cause Mortality by Heart Rate in HFpEF**



Number at risk

Heart rate ≥70 beats/min	2,031	1,431	1,139	898	738	222
Heart rate <70 beats/min	2,031	1,508	1,233	1,018	828	276

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This study assessed the association of discharge heart rate with outcomes in patients with heart failure (HF) with preserved ejection fraction (HFpEF), assembling a primary analysis cohort of 2,031 pairs of propensity score-matched patients with a discharge heart rate of <70 versus ≥70 beats/min. Propensity score-matched patients in the primary analysis cohort as well as in 3 sensitivity analyses cohorts with a heart rate <70 beats/min had a significantly lower risk of all-cause mortality compared with those with a heart rate ≥70 beats/min. The lower heart rate also was associated with a lower risk of a combination of HF readmission or all-cause mortality, but not of either HF or all-cause readmission separately.

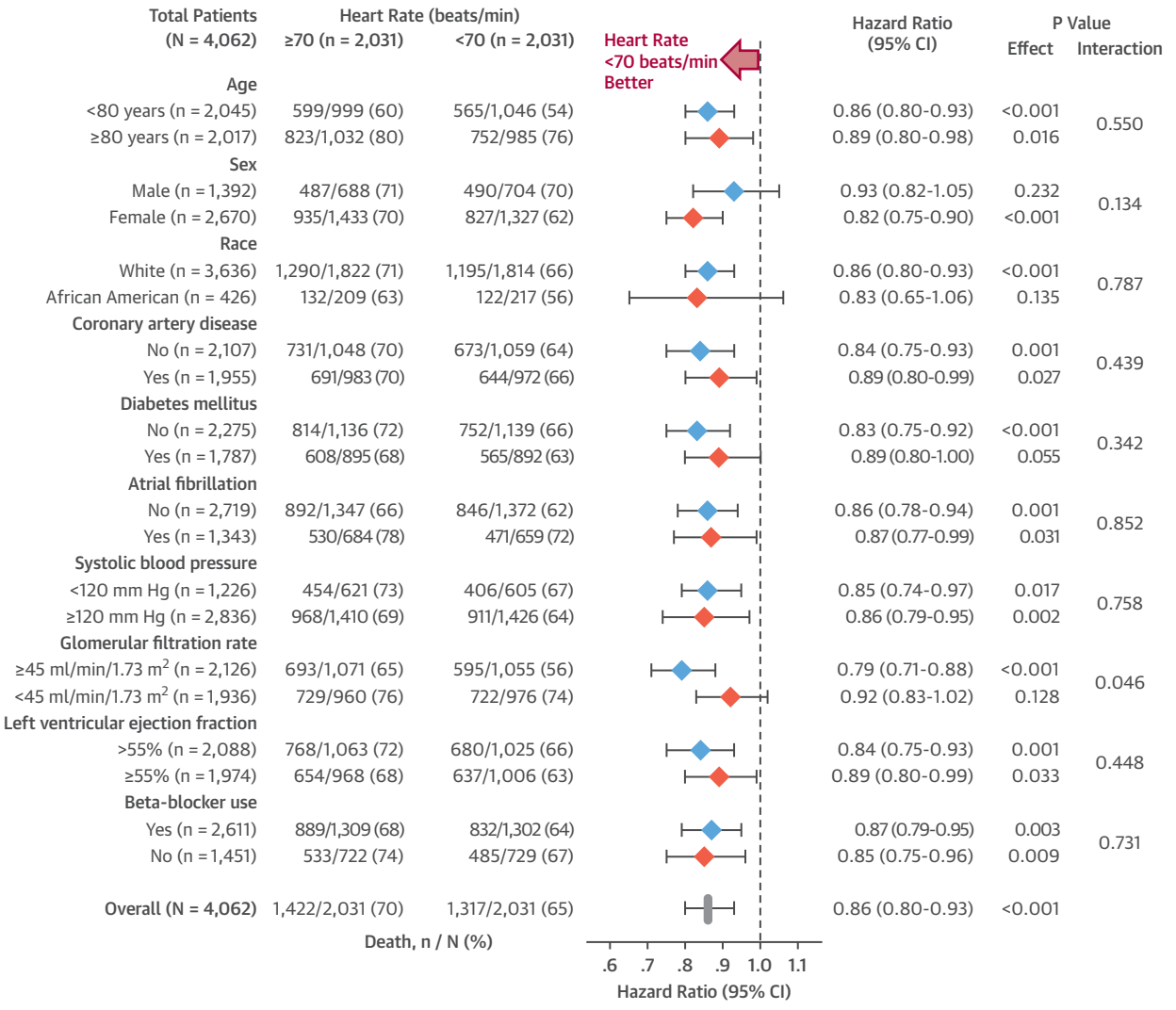
≥70 beats/min, respectively (HR: 0.89; 95% CI: 0.84 to 0.95; p < 0.001). Among 5,870 matched patients with EF ≥50% with valid admission heart rate that included patients with unstable inpatient heart rate, all-cause mortality occurred in 66% and 70% of patients with an admission heart rate <70 beats/min versus ≥70 beats/min, respectively (HR: 0.88; 95% CI: 0.83 to 0.94; p < 0.001). Among the 5,418 matched patients with EF >40% and stable heart rate, all-cause mortality occurred in 66% and 70% of patients with a discharge heart rate <70 beats/min versus ≥70 beats/min, respectively (HR: 0.88; 95% CI: 0.82 to 0.94; p < 0.001).

DISCHARGE HEART RATE AND OTHER OUTCOMES. Among the 4,062 matched patients with EF ≥50% and stable heart rate, a discharge heart rate <70 beats/min was associated with a lower rate of the combined endpoint of HF readmission or all-cause mortality, but had no association with all-cause readmission or HF readmission (Table 2). A discharge heart rate <70 beats/min had no significant association with all-cause readmission when death was treated as a competing risk in the Fine-Gray model (HR: 1.02; 95% CI: 0.96 to 1.09; p = 0.544). A similar lack of association was also observed in the Fine-Gray model for HF readmission (HR: 1.02; 95% CI: 0.93 to 1.11; p = 0.690).

DISCUSSION

Findings from our study demonstrated that among hospitalized patients with HFpEF, a discharge heart rate of <70 beats/min was associated with a significantly lower risk of all-cause mortality. A heart rate <70 beats/min also was associated with a lower risk of the combined endpoint of HF readmission or all-cause mortality. However, a lower heart rate had no

FIGURE 3 Forest Plots for Subgroup Analyses of Mortality by Heart Rate

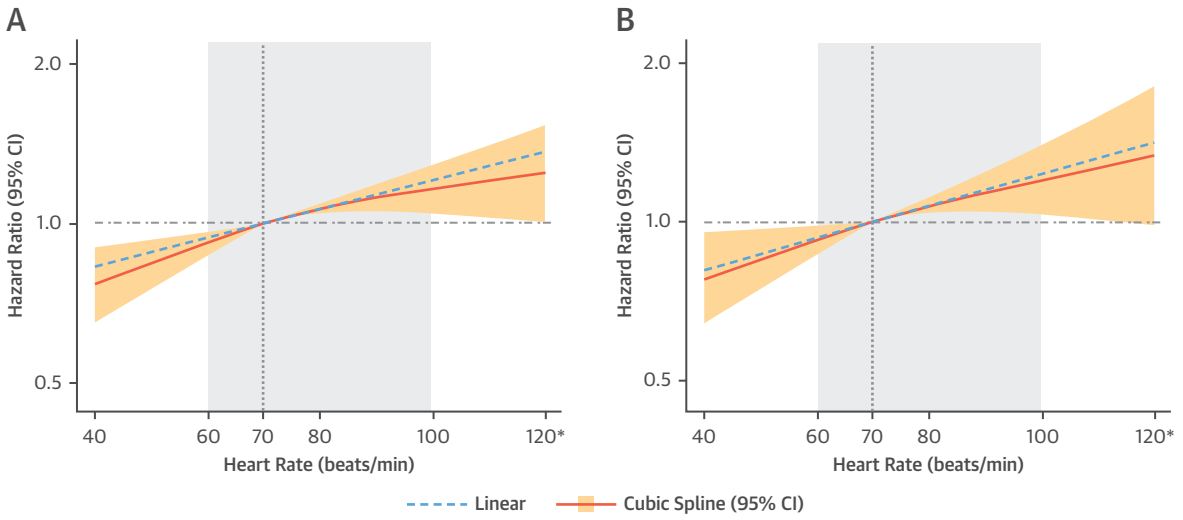


In all variables analyzed, patients with lower heart rates had lower rates of mortality compared to patients with heart rates ≥70 beats/min. CI = confidence interval.

significant association with HF or all-cause readmission. To the best of our knowledge, this is the first study to demonstrate a beneficial association between a lower heart rate and subsequent long-term outcomes in 4 separate propensity score-matched cohorts of patients with HFpEF from a national HF registry using different EF cutoffs and heart rate criteria.

There are several potential explanations for our findings. A lower resting heart rate would be expected to be a marker of attenuated sympathetic tone and, consequently, lower levels of atherogenesis, myocardial ischemia, and left ventricular dysfunction (23-27). However, before matching, we found that patients with a heart rate <70 beats/min had a significantly higher prevalence of coronary artery disease, prior myocardial infarction and coronary revascularization, and a significantly higher proportion of these patients were receiving angiotensin-converting enzyme inhibitors and beta-blockers. It is possible that the higher use of beta-blockers in patients with a heart rate <70 beats/min was in part driven by the higher prevalence of coronary artery disease in that group. Thus, an intrinsically attenuated sympathetic tone would be unlikely to explain the lower mortality in patients with a heart rate <70 beats/min in our study.

FIGURE 4 All-Cause Mortality by Heart Rate: Restricted Cubic Spline Plots



In cubic spline analysis, no nonlinear relationship between heart rate and all-cause mortality was found in either **(A)** 6,286 pre-match patients, adjusting for propensity scores, or **(B)** 4,062 matched patients balanced on 58 baseline characteristics (nonlinearity $p > 0.20$ for both pre-match and matched data). *Spline curves truncated at heart rate = 120 beats/min (9 pre-match patients and none of the matched patients had a heart rate >120 beats/min). **Solid orange lines** represent hazard ratios, and **light orange shaded areas** represent 95% CIs. **Light gray rectangles** = normal heart rate range of 60 to 100 beats/min. CI = confidence interval.

However, a heart rate <70 beats/min was also associated with a lower risk of death in patients not receiving beta-blockers, suggesting a potential beneficial role of an intrinsically attenuated sympathetic tone. An attenuated sympathetic tone would also be expected to reduce pro-arrhythmic propensity and sudden cardiac death, a relatively more common mode of cardiovascular death (versus pump failure death) in patients with HFpEF (28,29). Sudden cardiac deaths outside the hospital would preclude readmission, which might in part explain the higher risk of death, but not of readmission, in the higher heart rate group in our study.

Several prior studies have examined the association of heart rate with outcomes in HFpEF (6,30,31). However, these studies are limited by small sample size, single sex, inclusion of both HFrEF and HFpEF, and use of trial-eligible younger patients. By contrast, our study was distinguished by a national cohort of real-world older patients, the use of an EF cutoff of 50% to define HFpEF, the use of propensity score matching to assemble a balanced cohort, the use of subgroup analyses to demonstrate homogeneity, the use of multiple sensitivity analyses to demonstrate robustness of association, and the use of formal sensitivity analyses to assess bias by a potential unmeasured confounder.

Our study has important clinical implications. These findings suggest that a higher heart rate is a marker of poor prognosis in patients with HFpEF and that it might be an independent risk factor for mortality. These findings might tempt one to suggest that a discharge prescription of beta-blockers or other heart rate-lowering drugs might be beneficial. Findings from our subgroup analysis suggest that a lower heart rate was associated with lower mortality regardless of use of beta-blockers. However, it remains unclear whether a reduction of heart rate in patients with HFpEF and a higher heart rate through initiation or up-titration of the dose of beta-blockers would be associated with improved outcomes (32,33). Findings to date from heart rate-lowering interventions, including beta-blockers, in HFpEF have not found any evidence of clinical benefit (34–38). However, many of these studies were limited by small sample size, use of surrogate endpoints, and inclusion of patients with a normal heart rate. Future prospective studies need to examine this association in the high-risk subset of HFpEF patients with elevated heart rate.

STUDY LIMITATIONS. Despite propensity score matching, bias due to an unmeasured confounder was possible. However, findings from our sensitivity

analysis suggest that the beneficial association of a heart rate <70 beats/min and all-cause mortality was rather insensitive to a hidden bias. A hidden covariate could explain away this association if it would also increase the odds of having a heart rate <70 beats/min by about 8%. However, it is an unlikely possibility: for an imaginary unmeasured binary covariate to become a confounder, it would also need to be a near perfect predictor of mortality and could not be strongly correlated to any of the 58 variables used in our propensity score model. We had no data on heart rate before hospital admission. If baseline characteristics were affected by the prevalent heart rate, it might potentially underestimate true associations. Finally, our analysis was restricted to fee-for-service Medicare beneficiaries, which might limit generalizability.

CONCLUSIONS

In hospitalized older patients with HFpEF, a discharge heart rate <70 beats/min was independently associated with a lower risk of all-cause mortality, but had no association with all-cause or HF readmission. These findings suggest that the beneficial association of a lower heart rate and improved survival observed in patients with HFrEF might extend to those with HFpEF. Future studies are needed to develop and test interventions that might improve outcomes in patients with HFpEF and elevated heart rate.

ADDRESS FOR CORRESPONDENCE: Dr. Ali Ahmed, Center for Health and Aging (1D 129D), Washington DC VA Medical Center, 50 Irving Street NW, Washington, DC 20422. E-mail: aliahmedmdmph@gmail.com.

PERSPECTIVES

COMPETENCY IN MEDICAL KNOWLEDGE: In patients with HFpEF hospitalized for decompensated HF, a lower heart rate at the time of discharge is associated with a lower risk of mortality during follow-up, regardless of atrial fibrillation or beta-blocker therapy.

TRANSLATIONAL OUTLOOK: Prospective studies are needed to evaluate the impact of heart rate-lowering interventions on outcomes in patients with HFpEF and elevated heart rates.

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