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Race/Ethnic Differences in Outcomes Among Hospitalized Medicare Patients with Heart Failure and Preserved Ejection Fraction: Findings from Get With The Guidelines-Heart Failure

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Abstract (Word Count = 272, limit 250**)**

Background: The proportion of hospitalizations for heart failure with preserved ejection fraction (HFpEF) has increased over the last decade. Whether short and long-term outcomes differ between racial/ethnic groups is not well described.

Objectives: This study analyzed HFpEF patient characteristics and clinical outcomes based on race/ethnicity and adjusted for patient and hospital characteristics along with socioeconomic status (SES).

Methods: The Get With The Guidelines-Heart Failure registry was linked to Medicare administrative data to identify hospitalized HFpEF patients age ≥65 with LVEF ≥50% between 2006 and 2014. Cox proportional hazards models were used to report hazard ratios (HR) for 30-day and 1-year readmission and mortality rates with sequential adjustments for patient characteristics, hospital characteristics, and SES.

Results: The final cohort included 53,065 HFpEF patients. Overall 30-day mortality was 5.87% and 33.1% at 1 year. 30-day all-cause readmission rate was 22.2% and 67.0% at 1-year. After adjusting for patient characteristics, hospital characteristics, and SES, 30-day mortality was lower for black (HR=0.84; 95% CI: 0.71-0.98, p-value=0.031) and Hispanic (HR=0.78; 95% CI: 0.64-0.96, p-value=0.017) compared with white patients. 1-year mortality was lower for black (HR=0.93; 95% CI: 0.87-0.99, p-value=0.031), Hispanic (HR=0.83; 95% CI: 0.75-0.91, p-value <0.001) and Asian (HR=0.76; 95% CI: 0.66-0.88, p-value <0.001) compared with white patients. Black patients had a higher risk of readmission at 30 days (HR=1.09; 95% CI: 1.02–1.16, p-

value=0.012) and 1 year (HR=1.14; 95% CI: 1.09–1.20, p-value <0.001) compared with white patients.

Conclusions: Black, Hispanic, and Asian patients have a lower mortality risk after a HFpEF hospitalization compared with white patients. Black patients have higher readmission rates. These differences in mortality and readmission risk based on race/ethnicity persist after adjusting for patient characteristics, SES, and hospital factors.

Abbreviations

BMI = body mass index

CMS = Centers for Medicare and Medicaid Services

GWTG-HF = Get With The Guidelines-Heart Failure

HF = heart failure

HFpEF = heart failure with preserved ejection fraction

HFrEF = heart failure with reduced ejection fraction

HR = hazard ratio

IQR = interquartile ranges

SES = socioeconomic status

Introduction

Heart failure (HF) is an increasing public health burden in the United States with an estimated 5.7 million adults self-reporting the condition in 2012 (1). By 2030 the prevalence of HF is expected to increase 46% to over 8 million people secondary to an aging demographic nationally (2). While reductions in ischemic heart disease have lowered the age-standardized rates of heart failure with reduced ejection fraction (HFrEF), the proportion of patients with heart failure with preserved ejection fraction (HFpEF) has increased over the last decade (3, 4).

Prior research on the epidemiology and outcomes among HFpEF patients is limited. Hypertension is the strongest known risk factor for HFpEF, along with age, obesity and diabetes mellitus (5, 6). Among hospitalized Medicare HF patients, HFpEF patients have an observed lower mortality but higher readmission rate compared to HFrEF patients (7). While adequate control of hypertension and volume status are critical to managing symptoms, effective therapies regrettably are not shown to alter the natural history of disease or improve survival for HFpEF patients (8).

The quality of cardiovascular care for racial and ethnic minorities is known to vary (9). The rate of preventable hospitalizations for conditions that include HF is highest for blacks and Hispanics when compared with whites (10). Blacks and Hispanic hospitalized with HFrEF exacerbations have a higher 30-day and 1-year readmission rates and lower 30-day and 1-year mortality rates when compared to whites (11). There have not been comparable studies assessing outcomes in hospitalized HFpEF patients by race/ethnicity. This study reports on the differences in patient characteristics and clinical outcomes for hospitalized HFpEF patients by race/ethnic groups using the Get With The Guidelines-Heart Failure (GWTG-HF) registry linked to the Centers for Medicare and Medicaid Services (CMS) administrative data.

Methods

Cohort

Patients discharged from the GWTG-HF registry between January 1, 2006 and December 1, 2014 were screened. All patients included in GWTG-HF registry have been identified by medical providers based on clinically diagnosed HF. Inclusion in the final cohort required age ≥ 65, eligible for Medicare Part A and B fee for service benefit during the discharge month, and left ventricular ejection fraction (LVEF) $\geq 50\%$ on quantitative assessment, or if not quantitative LVEF not available, qualitative assessment of normal or mild dysfunction was included. LVEF criteria were consistent with recent society guideline definitions (8, 12). Patients were excluded if they were transferred to a hospice facility, left against medical advice, discharge disposition was unknown, or regional socioeconomic status (SES) was not available for linkage. The GWTG-HF registry was linked to CMS administrative data providing utilization of services, expenditures, and 30-day and 1-year outcomes data.

Statistical Analysis

Baseline patient and hospital characteristics were described by race/ethnic groups. Patient factors included age, gender, medical history, vital signs, body-mass index (BMI), laboratory tests (BUN, serum creatinine, serum sodium, hemoglobin, hemoglobin A1c, and lipid panel). Hospital characteristics included region, rural location, teaching status, and size. Percentages and median interquartile ranges (IQR) were reported for categorical and continuous variables respectively. The Pearson chi-squared test was used to compare categorical variables and the

Wilcoxon rank-sum tests was used to compare ordinal categorical variables or continuous variables. Standardized differences were provided between groups.

SES was linked using patient zip code geocoding to the 2015 Area Health Resource File provided through the Health Resources and Services Administration. SES variables included median household income, median home value, percentage with high school diploma, and percentage with $\geq$4 years of college (13).

The primary outcomes included 30-day and 1-year mortality and readmission rates by cause. Kaplan-Meier estimates of 30-day/1-year mortality outcomes were reported across race groups and compared using log-rank tests. The cumulative incidence function of readmission outcomes at 30-day/1-year were reported across race groups and compared using Gray's test, which determines if the cumulative incidence functions are equal across treatment groups. A Cox proportional hazards model was used for 30-day and 1-year outcomes and ties were handled using the Efron method. The models were adjusted sequentially for patient and hospital characteristics followed by patient SES based on zip code (online-only Data Supplement Tables I, II, III). Control variables were selected based on a literature review and prior established models used in GWTG-HF (7, 11, 13).

Patient covariates with missingness were imputed for the Cox model (online-only Data Supplement Table IV). Missing medical histories were imputed to not present. Multiple imputation with 25 datasets were used to impute other patient covariates. Hospital characteristics were not imputed. Patient's SES variables were assigned values from census data of the year closest to the patient's year of admission. Any dollar values of previous years were adjusted to 2015 US dollars based on the Consumer Price Index.

Results

The final cohort included 53,065 patients (online-only Data Supplement Tables V, VI, VII, VIII). The average age of hospitalization was 83 for white, 77 for black, 79 for Hispanic, and 81 for Asian patients (Table 1). Blacks and Hispanics had a notable younger age distribution. The proportion of females was higher among blacks in comparison to other ethnic groups. Blacks and Hispanics had lower rates of atrial fibrillation compared to the other ethnic groups. Blacks and Hispanics had higher rates of diabetes, hypertension, and median body-mass index. Among blacks, Hispanics, and Asians rates of chronic renal disease and dialysis were significantly higher. Systolic blood pressure on presentation was highest among blacks, followed by Hispanics and Asians. LVEF was not considerably different between the racial/ethnic groups. A larger proportion of blacks received treatment in teaching hospitals.

With respect to inpatient procedures, minority patients had higher rates of dialysis (Table 2). On discharge, blacks had generally higher rates of anti-hypertensive and diabetic medication prescription. Inpatient mortality was highest among Asian (3.44%) and white (3.01%) patients and lowest among black (1.70%) and Hispanic (2.30%) patients. Mortality at 30-days and 1-year were 5.87% and 33.10% respectively for the overall cohort with lower rates among minority patients compared with whites (Table 3 and Figure 1). The 30-day and 1-year all-cause readmission rates were 22.16% and 66.95% respectively for the overall cohort with higher rates among blacks and Hispanics compared to whites. Blacks had the highest readmission rate for cardiovascular and HF related primary diagnoses at 1-year.

When controlling for hospital and patient factors, black and Hispanic ethnicities were associated with lower 30-day mortality compared to whites (Table 4, online-only Data Supplement Table IX). Mortality at 1-year was lower as well for blacks, Hispanics, and Asians. The lower mortality rates persisted when adjusting for patient SES for blacks and Hispanics. All-cause 30-day and 1-year readmissions were higher among blacks when compared to whites when controlling for patient, hospital, and SES variables. While Hispanics had a similar hazard ratio for all-cause readmissions at 30-days, this did not meet statistical significance across all models. Hispanics did have a higher risk of cardiovascular and heart failure related readmissions when compared with whites that was statistically significant when controlling for patient characteristics, hospital characteristics, and regional SES. Blacks had a 12% higher hazard ratio for the composite endpoint of 1-year mortality and readmission when compared to whites in the fully adjusted model.

Discussion

This study reports the differences in HFpEF patient characteristics both short- and long-term outcomes based on race/ethnicity after an acute HF hospitalization using a large observational cohort from the GWTG-HF registry linked to CMS administrative data. HFpEF is an increasing portion of HF hospitalizations and a growing national burden. A HFpEF admission portends considerable risk of future hospitalization and mortality. The study finds that minorities generally had lower 30-day and 1-year mortality rates and higher readmission rates when compared to whites with significant differences in comorbidity burden.

Black and Hispanic HFpEF patients had higher systolic blood pressure and BMI. With respect to comorbidities, black and Hispanic patients had higher rates of diabetes, hypertension, and renal insufficiency. These findings suggest that the known risk factors for HFpEF are more prevalent among minority patients (5, 6). The differences in comorbidities based on race/ethnicity among HFpEF patients is consistent with the observed trends in cardiovascular risk factors among minorities nationally where the prevalence of obesity, poorly controlled hypertension, and diabetes has increased (10). Obesity is a strong risk factor for incident HFpEF among women and especially black women (14). Therefore, much of the current HFpEF burden may be preventable through improvements in cardiovascular risk reduction of known risk factors that predispose to left ventricular diastolic dysfunction and the HFpEF syndrome.

While post-discharge mortality is observed to be lower for black patients, the age-adjusted prevalence of HFpEF is significantly higher, and the per capita death rate for HFpEF may still be higher for black and Hispanic HFpEF patients compared to white patients (15). The lower short- and long-term mortality among minorities may indicate differences with regards to HFpEF stage. Hospitalized minority patients may include a larger proportion of new or recent onset disease with lower rates of 30-day and 1-year mortality. Within this Medicare cohort, black HFpEF patients were 5 years younger on average at index admission than whites. Life expectancy is observed to be significantly lower among blacks with cardiovascular conditions compared to whites (16). From the perspective of a patient's life course, we would expect minorities to have a greater risk for incident HFpEF and a shorter life expectancy secondary to the condition.

Much of the mortality hazard was reduced when adjusting for patient level factors, suggesting that objective vitals, laboratory data, and comorbidities contribute to the differences

in risk based on race/ethnicity. Differences in outcomes persisted when adjusting for hospital and SES among black patients. This suggests that the adjustments for regional SES did not contribute to the observed differences in hazard between race/ethnic groups. The persistence of measured differences by race/ethnicity despite the given adjustments suggests additional factors outside of the model should be considered. Lower quality transitional and outpatient care, neighborhood deprivation, unmeasured provider bias may better explain the higher readmission risk for black patients (17). Minority patients in low-income communities face significant barriers in receiving access to quality cardiovascular care. Despite this entire cohort having access to Medicare insurance benefits, the ability to afford copayments for follow-up appointments and prescription medications may still contribute to observed disparities. Clinics in deprived neighborhoods may not have the payer mix necessary to support additional support staff, providers, and specialists required for early and frequent follow-up visits post-hospitalization.

The higher short- and long-term mortality rate among white HFpEF patients is a competing risk that potentially confounds the higher observed readmission rates for black and Hispanic patients. However, the composite endpoint of readmission and mortality remained significantly higher among blacks when compared with whites in the fully adjusted model. Hispanics appeared to have a similarly elevated hazard for readmission risk relative to whites as black patients did, but statistical significance was not reached across all models. The smaller cohort size for Hispanics and number of events may have limited the statistical power to detect differences in the readmission hazard. Among Asians, there was a suggestion that the composite endpoint was lower compared with whites.

Previous studies reported that HFpEF patients have lower mortality rates and higher all-cause readmission rates when compared to HFrEF patients (7). A prior GWTG-HF registry study

reporting outcomes post-hospitalization for all HF syndromes noted similarly lower mortality rates and higher readmission rates among black and Hispanic HF patients when controlling for patient factors consistent with these findings (18). The Irbestartan in Heart Failure with Preserved Ejection Fraction Trial reported that approximately 40% of readmissions were for recurrent HF exacerbations (19). Biomarkers such as N-terminal pro-B-type natriuretic peptide are associated with a higher risk of hospitalization and mortality among HFpEF patients (20). Given the high rates of readmission, future studies should consider risk stratifying patients for post-hospitalization interventions that may reduce the HFpEF readmission burden. Identifying additional evidenced medical therapies to reduce the HF hospitalization and mortality are also needed (21).

Limitations

The diagnosis of HFpEF was based on the assessment of LVEF and the clinical presentation of HF. The definition for HFpEF was based on the most recent society guidelines; prior studies have defined HFpEF with a LVEF as low as 40% (22). Although some guidelines recommend abnormal levels of natriuretic peptides and assessment of diastolic dysfunction or relevant structural heart disease, additional echocardiographic data are not available in the registry (8, 12). However, the proportion of patients with a B-type natriuretic peptide >100 pg/ml or N-terminal pro b-type natriuretic peptide > 300 pg/ml was 94.0% and comparable to prior reports of the false-negative rate for natriuretic peptide in patients with clinically diagnosed HF (23–25). The uniform assessment of LVEF in this registry is also lacking as different imaging modalities, echocardiography (2-D, 3-D, contrast), cardiac magnetic resonance imaging, angiography, may have been used to determine cardiac systolic function. While this potentially

limits standardized HFpEF definitions, the patient population may be more reflective of real-world clinical diagnosis. The study was limited to hospitals participating in the GWTG-HF registry and patients with Medicare benefits. Patients are generally older and may not be entirely representative of the general HFpEF population. The specific cause of death was not available to be able to determine contributing factors. Hospitals participating in the GWTG-HF registry may not be representative of hospitals nationally. Patient race/ethnicity is self-designated as recorded by administrative staff or medical providers and may be less accurate than direct patient reporting. The SES variables were limited to geocoding based on a patient's zip code and may be insufficient to measure differences in SES between patients. The smaller sample size for Asian patients with HFpEF limited the statistical strength of observations in the Cox proportional hazards models. Lower observed mortality rates for black and Hispanic patients in this analysis does not account for a potentially higher rate of mortality prior to index admission.

Conclusion

Patients with HFpEF are an increasing proportion of acute HF admissions. Black and Hispanic patients with HFpEF have lower rates of short-term and long-term mortality compared to white patients when controlling for patient and hospital risk factors. Black and Hispanic patients with HFpEF have a higher rate of hospital utilization after an index admission when controlling for patient and hospital factors. Minority patients have a higher prevalence of preventable comorbidities that complicate the management of HFpEF. More research is needed to help improve outcomes, narrow disparities, and reduce acute hospital utilization for HFpEF patients.

Perspective:

Competency in Medical Knowledge: HFpEF is an increasing proportion of acute HF hospitalizations. Variations in outcomes based on race/ethnicity persist when accounting for patient risk factors and regional socioeconomic status.

Translational Outlook: Future studies are needed to improve survival for all patients with HFpEF and reduce the hospitalization burden. Targeted interventions may be needed to improve transitions after hospitalization for minority patients at high-risk for readmission.

Central Illustration: Graphic: revolving door hospital discharge/admission.

Outcomes in HFpEF by Race/Ethnic Group

RACE/ETHNIC GROUP	MEAN AGE	1-YEAR MORTALITY	1-YEAR REHOSPITALIZATION	1-YEAR DEATH REHOSPITALIZATION
WHITE	*83*	*ref*	*ref*	*ref*
BLACK	77	↓	↑	↑
HISPANIC	79	↓	→	→
ASIAN	81	↓	→	↓
OTHER	77	→	→	→

Keywords: heart failure with preserved ejection fraction, diastolic heart failure, race, ethnicity, disparities, hospitalization, mortality

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Tables and Figures

Table 1: Baseline patient and hospital characteristics for overall HFpEF patients and by race/ethnic groups.

Variables	Overall (N=53,065)	White (N=44,871)	Black (N=4,767)	Hispanic (N=2,260)	Asian (N=842)	Other (N=325)	P-value	Standardized Difference White vs ... Black	Hispanic	Asian	Other
Demographics											
Age, years, median (IQR)	82 (75 - 88)	83 (76 - 88)	77 (71 - 84)	79 (72 - 85)	81 (75 - 87)	77 (71 - 83)	<.0001	0.521	0.346	0.134	0.517
Age (Categorical)							<.0001				
65-69	10.65	9.26	20.54	16.02	11.64	17.54		0.321	0.204	0.078	0.245
70-74	12.76	11.79	19.93	16.46	11.28	19.69		0.224	0.134	0.016	0.218
75-79	16.10	15.56	19.13	18.58	19.95	18.77		0.094	0.080	0.115	0.085
>=80	60.49	63.39	40.40	48.94	57.13	44.00		0.473	0.294	0.128	0.396
Female	66.24	65.75	70.40	68.32	62.47	68.31	<.0001	0.100	0.055	0.068	0.055
Medical History											
Atrial Flutter/Fibrillation	44.12	47.33	25.33	25.44	31.85	32.55	<.0001	0.470	0.467	0.320	0.305
COPD or Asthma	31.54	31.76	32.73	28.51	22.34	28.86	<.0001	0.021	0.071	0.213	0.063
Diabetes (Insulin or non-insulin treated)	39.17	36.36	56.38	56.03	43.91	50.00	<.0001	0.410	0.402	0.154	0.278
Hyperlipidemia	49.05	49.26	47.22	48.84	49.11	47.32	0.1314	0.041	0.008	0.003	0.039
Hypertension	81.29	80.22	89.76	84.73	82.74	78.86	<.0001	0.270	0.119	0.065	0.034
Peripheral Vascular Disease	12.49	12.75	11.70	11.87	5.46	11.07	<.0001	0.032	0.027	0.256	0.052
CAD	44.51	45.33	37.26	44.44	41.24	45.30	<.0001	0.165	0.018	0.083	0.001
Prior MI	13.07	13.41	11.29	11.30	9.77	12.42	<.0001	0.064	0.064	0.114	0.030
CVA/TIA	16.88	16.70	19.82	15.18	16.12	12.42	<.0001	0.081	0.042	0.016	0.122
ICD only	1.43	1.48	1.26	1.09	1.02	1.01	0.3242	0.019	0.035	0.042	0.042
Anemia	22.22	21.93	26.25	20.57	18.78	24.16	<.0001	0.101	0.033	0.078	0.053
Dialysis (chronic)	3.19	2.21	8.82	8.09	9.26	8.05	<.0001	0.293	0.268	0.307	0.267
Renal insufficiency – chronic (SCr>2.0)	20.48	19.14	30.42	24.21	24.75	25.17	<.0001	0.263	0.123	0.136	0.146
Depression	11.97	12.73	7.02	10.26	5.20	7.38	<.0001	0.192	0.077	0.266	0.178
Ischemic Etiology: medical history of CAD, MI, prior PCI, prior CABG, or prior PCI/CABG	49.34	50.23	41.26	49.93	45.18	49.66	<.0001	0.181	0.006	0.101	0.011
Medical History Panel Missing	5.69	5.50	6.75	6.42	6.41	8.31	0.0005	0.052	0.039	0.038	0.111
Smoking	6.92	6.64	10.05	6.75	4.32	7.17	<.0001	0.124	0.004	0.102	0.021
Vitals on Admission											
Heart Rate, bpm, median (IQR)	79 (68 - 92)	79 (68 - 92)	79 (68 - 91)	78 (68 - 91)	77 (68 - 93)	80 (69 - 92)	0.459	0.007	0.025	0.007	0.033
SBP, mmHg, median (IQR)	144 (125 - 165)	143 (124 - 163)	153 (133 - 178)	149 (130 - 172)	147 (128 - 166)	144 (123 - 162)	<.0001	0.345	0.218	0.118	0.000
DBP, mmHg, median (IQR)	72 (62 - 84)	72 (62 - 83)	76 (66 - 88)	72 (62 - 84)	72 (62 - 84)	73 (63 - 84)	<.0001	0.271	0.057	0.021	0.078
BMI, median (IQR)	27.66	27.46	30.07	29	23.84	29.26	<.0001	0.320	0.157	0.567	0.108

Variables	Overall (N=53,065)	White (N=44,871)	Black (N=4,767)	Hispanic (N=2,260)	Asian (N=842)	Other (N=325)	P-value	Standardized Difference White vs ...			
								Black	Hispanic	Asian	Other
	(23.43 - 33.27)	(23.27 - 32.95)	(25.21 - 36.33)	(24.61 - 34.06)	(21.03 - 27.55)	(24.47 - 34.55)					
Lab Measures											
LVEF Source							0.0155				
Quantitative LVEF	91.31	91.17	92.22	91.55	93.59	90.15		0.038	0.013	0.091	0.035
Qualitative LVEF	8.69	8.83	7.78	8.45	6.41	9.85		0.038	0.013	0.091	0.035
EF, %, median (IQR)	60	60	60	60	60	60	<.0001	0.082	0.026	0.130	0.100
	(55 - 64)	(55 - 64)	(55 - 65)	(55 - 65)	(55 - 65)	(55 - 65)					
Serum creatinine, mg/dL, median (IQR)	1.2	1.2	1.5	1.3	1.3	1.3	<.0001	0.127	0.090	0.109	0.102
	(0.9 - 1.7)	(0.9 - 1.7)	(1.1 - 2.4)	(0.9 - 2)	(0.9 - 2.1)	(0.9 - 2.1)					
Serum sodium mEq/L, median (IQR)	138	138	139	138	137	138	<.0001	0.107	0.141	0.130	0.054
	(135 - 141)	(135 - 141)	(137 - 142)	(135 - 140)	(134 - 140)	(135 - 140)					
BUN, mg/dL, median (IQR)	25	25	25	25	26	25	0.0086	0.057	0.106	0.136	0.111
	(18 - 36)	(18 - 36)	(17 - 39)	(18 - 40)	(18 - 39.5)	(17.5 - 40.5)					
BNP, Admission pg/mL, median (IQR)	562	560	571	564	627	598	0.4905	0.130	0.085	0.079	0.029
	(297 - 1038.8)	(304 - 1020)	(234.5 - 1199.5)	(270 - 1120)	(316 - 1140)	(275.5 - 1120.5)					
Hemoglobin, g/dL, median (IQR)	11.4	11.5	10.9	11.3	11.3	10.9	<.0001	0.168	0.069	0.007	0.274
	(10.1 - 12.8)	(10.2 - 12.8)	(9.6 - 12.2)	(9.9 - 12.5)	(10 - 12.7)	(9.6 - 12.2)					
HbA1C (0-20), %, median (IQR)	6.5	6.5	6.6	6.8	6.6	6.5	0.0102	0.078	0.188	0.017	0.166
	(5.9 - 7.4)	(5.9 - 7.3)	(5.9 - 7.6)	(6 - 7.7)	(6 - 7.3)	(6 - 8.4)					
Total Cholesterol (10-1000), mg/dL, median (IQR)	135	134	142	134	139	121	<.0001	0.214	0.099	0.152	0.279
	(112 - 163)	(111 - 161)	(118 - 172)	(114 - 166)	(116 - 166)	(102 - 147)					
HDL (0-120), mg/dL, median (IQR)	41	40	46	41	42	40	<.0001	0.299	0.039	0.141	0.033
	(33 - 51)	(32 - 51)	(36 - 56)	(32 - 52)	(35 - 52)	(32 - 47)					
LDL (30-500), mg/dL, median (IQR)	73	72	78	72	74	64	<.0001	0.188	0.074	0.045	0.200
	(56 - 94)	(55 - 94)	(58 - 101)	(57 - 97)	(59 - 92)	(50 - 89)					
Triglycerides (5-2000), mg/dL, median (IQR)	88	89	78	95	93	94	<.0001	0.223	0.123	0.027	0.036
	(65 - 122)	(66 - 123)	(59 - 110)	(70 - 132)	(64 - 127)	(69.5 - 126)					
Admission Medications											
ACE-I	29.43	29.41	30.61	29.81	21.50	33.16	0.0007	0.026	0.009	0.183	0.081
ARB	16.98	16.23	19.32	22.57	26.49	23.32	<.0001	0.081	0.161	0.252	0.179
Aldosterone antagonist	5.51	5.60	5.61	3.80	4.99	4.66	0.0551	0.000	0.086	0.027	0.043
Aspirin	44.40	45.14	40.84	40.10	32.82	53.37	<.0001	0.087	0.102	0.255	0.165
Beta-Blocker	54.93	55.05	54.41	55.21	50.10	54.92	0.2437	0.013	0.003	0.099	0.003
Diabetic medications (Any)	23.56	21.56	34.00	36.92	31.36	35.38	<.0001	0.281	0.343	0.224	0.310
Anticoagulation therapy	27.57	29.61	16.98	14.98	15.36	15.54	<.0001	0.302	0.357	0.347	0.341
Diuretic	60.75	61.87	56.96	52.86	44.15	57.51	<.0001	0.100	0.183	0.361	0.089
Hydralazine	6.78	5.80	15.01	9.73	6.91	4.66	<.0001	0.305	0.147	0.046	0.051
Lipid lowering agent (Any)	55.05	54.71	56.89	57.00	55.09	62.69	0.0166	0.044	0.046	0.008	0.163
Year of index admission							<.0001				
2006	7.11	7.23	7.53	5.00	5.34	3.08		0.011	0.093	0.078	0.189
2007	6.90	6.82	8.27	6.90	4.04	4.62		0.055	0.003	0.123	0.095
2008	6.98	6.79	7.97	7.79	8.43	9.85		0.045	0.038	0.062	0.111
2009	8.70	8.67	9.38	7.74	8.67	9.23		0.025	0.034	0.000	0.020

Variables	Overall (N=53,065)	White (N=44,871)	Black (N=4,767)	Hispanic (N=2,260)	Asian (N=842)	Other (N=325)	P-value	Standardized Difference White vs …			
								Black	Hispanic	Asian	Other
2010	11.00	10.85	11.29	11.73	14.01	14.77		0.014	0.028	0.096	0.118
2011	13.05	12.95	13.03	13.36	14.73	21.54		0.002	0.012	0.052	0.229
2012	14.12	14.26	12.99	12.79	16.27	15.38		0.037	0.043	0.056	0.032
2013	16.33	16.39	15.42	17.43	16.98	12.00		0.027	0.028	0.016	0.126
2014	15.81	16.04	14.14	17.26	11.52	9.54		0.053	0.033	0.131	0.196
Hospital Characteristics											
Hospital Size (number of beds), median (IQR)	348 (227 - 527)	348 (222 - 481)	438 (292 - 610)	296 (243 - 438)	330 (217 - 400)	358 (194 - 368)	<.0001	0.444	0.008	0.047	0.186
Geographic Region							<.0001				
West	10.47	9.73	3.29	17.88	60.81	35.38		0.263	0.238	1.265	0.645
South	31.70	30.40	43.36	41.19	15.20	16.92		0.271	0.227	0.368	0.321
Midwest	23.14	24.13	22.99	8.41	8.79	28.62		0.027	0.436	0.423	0.102
Northeast	34.70	35.74	30.35	32.52	15.20	19.08		0.115	0.068	0.485	0.380
Rural Location	6.98	7.42	4.95	1.15	7.15	16.36	<.0001	0.103	0.313	0.010	0.279
Teaching Status	56.13	55.18	72.00	40.53	51.37	74.77	<.0001	0.355	0.296	0.076	0.420
Heart Transplants Performed at Site	9.22	9.11	12.72	5.16	7.71	5.56	<.0001	0.116	0.154	0.050	0.137

Legend: Values are means or %. Standardized differences are referenced to whites.
COPD = chronic obstructive pulmonary disease, CAD = coronary artery disease, MI = myocardial infarction, CVA = cerebrovascular accident, TIA = transient ischemic attack, ICD = implantable cardioverter defibrillator, SCr = serum creatinine, PCI = percutaneous coronary intervention, CABG = coronary artery bypass grafting, SBP = systolic blood pressure, DBP = diastolic blood pressure, BMI = body-mass index, LVEF = left ventricular ejection fraction, BUN = blood urea nitrogen, BNP = b-type natriuretic peptide, HbA1C = hemoglobin A1C, HDL = high-density lipoprotein, LDL = low-density lipoprotein, ACE-I = angiotensin converting enzyme inhibitors, ARB = angiotensin II receptor blocker.

Table 2: In-hospital therapies, procedures, medications on discharge, mortality and length of stay for the overall HFpEF patients by race/ethnicity.

Variables	Overall (N=53,065)	White (N=44,871)	Black (N=4,767)	Hispanic (N=2,260)	Asian (N=842)	Other (N=325)	P-value	Standardized Difference White vs ...			
								Black	Hispanic	Asian	Other
In-Hospital Procedures											
Cardiac Catheterization/Coronary angiography	4.71	4.73	5.04	4.01	3.13	5.85	0.2109	0.015	0.035	0.082	0.050
PCI	0.14	0.13	0.20	0.20	0.20	0.49	0.5747	0.015	0.016	0.015	0.064
Coronary artery bypass graft	0.27	0.26	0.33	0.27	0.39	0	0.8706	0.012	0.001	0.022	0.073
Cardiac Valve Surgery	0.35	0.37	0.20	0.27	0.39	0.49	0.6066	0.032	0.017	0.004	0.019
Pacemaker	1.01	1.02	0.98	0.94	0.98	0.98	0.9979	0.004	0.008	0.004	0.004
CRT-D	0.24	0.25	0.16	0.20	0	0	0.6011	0.019	0.011	0.071	0.071
ICD only	0.10	0.09	0.23	0.07	0	0	0.1609	0.035	0.008	0.042	0.042
Cardioversion	1.04	1.11	0.72	0.40	0.59	0.49	0.0168	0.041	0.082	0.057	0.070
Intra-aortic balloon pump	0.06	0.06	0.03	0.07	0.20	0	0.6926	0.011	0.005	0.040	0.033
Dialysis	2.92	2.29	6.78	5.61	7.63	8.78	<.0001	0.217	0.171	0.248	0.287
Ultrafiltration	0.19	0.18	0.49	0.07	0	0	0.0019	0.055	0.031	0.059	0.059
CRT-P	0.16	0.16	0.20	0.13	0.20	0	0.9498	0.009	0.006	0.009	0.056
Atrial Fibrillation Ablation or Surgery	0.08	0.08	0	0.07	0	0	0.5199	0.041	0.007	0.041	0.041
No Procedures	84.06	84.76	78.74	82.82	81.02	74.63	<.0001	0.156	0.053	0.100	0.254
Procedures are Missing	32.35	31.72	35.96	33.81	39.31	36.92	<.0001	0.090	0.044	0.159	0.110
Discharge Medications											
ACEi	34.37	34.08	37.58	36.48	26.06	32.58	<.0001	0.073	0.050	0.176	0.032
ARB	17.86	16.97	19.98	25.41	28.63	25.00	<.0001	0.078	0.208	0.280	0.198
Anticoagulation therapy	34.28	36.42	22.74	22.06	22.80	25.17	<.0001	0.303	0.320	0.302	0.246
Beta-blocker	73.65	73.62	74.25	72.70	74.78	73.33	0.9015	0.01	0.021	0.02	0.006

Variables	Overall (N=53,065)	White (N=44,871)	Black (N=4,767)	Hispanic (N=2,260)	Asian (N=842)	Other (N=325)	P-value	Standardized Difference White vs …			
								Black	Hispanic	Asian	Other
Aldosterone Antagonist	9.56	9.97	7.64	6.95	6.69	8.87	<.0001	0.084	0.109	0.117	0.037
Diabetic medications	40.81	38.03	55.44	56.58	48.92	50.00	<.0001	0.354	0.378	0.221	0.243
Lipid Lowering medications	56.19	55.63	57.70	61.18	59.74	64.68	<.0001	0.042	0.113	0.083	0.186
Hydralazine Nitrate	11.22	9.92	21.37	14.46	12.44	13.07	<.0001	0.319	0.139	0.080	0.099
Diuretic	44.75	45.24	42.71	41.84	39.29	40.95	<.0001	0.051	0.069	0.121	0.087
In-hospital Outcomes											
In-hospital death	2.87	3.01	1.70	2.30	3.44	3.08	<.0001	0.086	0.044	0.025	0.004
Length of hospital stay, day, median (IQR)	4 (3 - 6)	4 (3 - 6)	4 (3 - 7)	4 (3 - 7)	4 (3 - 6)	4 (3 - 6)	<.0001	0.082	0.081	0.048	0.027

Legend: Values are means or %. PCI = percutaneous coronary intervention, CRT-D = cardiac resynchronization therapy implantable cardioverter defibrillator, ICD = implantable cardioverter defibrillator, CRP-P = cardiac resynchronization therapy pacemaker, ACE-I = angiotensin converting enzyme inhibitors, ARB = angiotensin II receptor blocker.

Table 3: Mortality, readmission, and composite outcomes by race/ethnicity.

Outcomes	Overall	White	Black	Hispanic	Asian	Other	P-value
30d Follow-up Outcomes	(N=51,543)	(N=43,521)	(N=4,686)	(N=2,208)	(N=813)	(N=315)	
30d mortality*	5.87%	6.19%	4.05%	4.12%	4.06%	5.71%	<.0001
30d all-cause readmission	22.16%	21.87%	24.40%	24.35%	19.68%	20.76%	<.0001
30d CV readmission	10.48%	10.32%	11.52%	11.72%	10.09%	9.23%	0.0283
30d HF readmission	6.57%	6.44%	7.30%	7.95%	5.91%	5.73%	0.0101
30d composite of mortality and all-cause readmission	25.22%	25.14%	26.11%	26.43%	21.77%	24.51%	0.0601
1y Follow-up Outcomes	(N=43,212)	(N=36,380)	(N=4,003)	(N=1,832)	(N=715)	(N=282)	
1y mortality*	33.10%	34.26%	27.35%	25.98%	25.87%	29.08%	<.0001
1y all-cause readmission	66.95%	66.15%	73.49%	69.89%	63.54%	67.83%	<.0001
1y CV readmission	39.47%	38.40%	47.40%	44.72%	37.68%	37.56%	<.0001
1y HF readmission	25.98%	25.28%	31.19%	29.42%	24.27%	25.77%	<.0001
1y composite of mortality and all-cause readmission	74.46%	74.21%	77.82%	74.18%	69.33%	74.71%	0.0006

***Legend:*** Values are in %. CV = cardiovascular, HF = heart failure,

Table 4: Associations between follow-up outcomes and race/ethnicity controlling for patient factors, socioeconomic and hospital factors.

Outcomes	Race/Ethnic Groups	Unadjusted		Model 1		Model 2		Model 3	
		HR (95% CI)	P-value	HR (95% CI)	P-value	HR (95% CI)	P-value	HR (95% CI)	P-value
30-Day Mortality	Black	0.65 (0.55, 0.76)	<.001	0.85 (0.72, 0.99)	0.040	0.84 (0.71, 0.98)	0.029	0.84 (0.71, 0.98)	0.031
	Hispanic	0.66 (0.53, 0.81)	<.001	0.78 (0.65, 0.95)	0.012	0.78 (0.64, 0.95)	0.013	0.78 (0.64, 0.96)	0.017
	Asian	0.65 (0.42, 0.99)	0.043	0.70 (0.47, 1.06)	0.090	0.74 (0.49, 1.11)	0.143	0.76 (0.51, 1.14)	0.184
	Other	0.93 (0.63, 1.35)	0.694	1.15 (0.77, 1.73)	0.486	1.17 (0.78, 1.76)	0.444	1.17 (0.78, 1.75)	0.439
	White	Reference		Reference		Reference		Reference	
30-Day All-Cause Readmission	Black	1.12 (1.06, 1.19)	<.001	1.12 (1.05, 1.19)	<.001	1.10 (1.03, 1.17)	0.004	1.09 (1.02, 1.16)	0.012
	Hispanic	1.12 (0.99, 1.26)	0.070	1.12 (0.98, 1.27)	0.089	1.11 (0.98, 1.26)	0.104	1.07 (0.95, 1.22)	0.259
	Asian	0.88 (0.78, 1.00)	0.043	0.90 (0.79, 1.01)	0.082	0.96 (0.84, 1.10)	0.557	0.94 (0.82, 1.07)	0.313
	Other	0.94 (0.74, 1.18)	0.576	0.92 (0.74, 1.15)	0.482	0.97 (0.78, 1.21)	0.808	0.96 (0.78, 1.20)	0.748
	White	Reference		Reference		Reference		Reference	
30-Day Cardiovascular Readmission	Black	1.11 (1.01, 1.22)	0.025	1.11 (1.00, 1.22)	0.041	1.08 (0.98, 1.20)	0.114	1.07 (0.97, 1.18)	0.156
	Hispanic	1.14 (1.01, 1.28)	0.032	1.12 (0.99, 1.25)	0.066	1.10 (0.98, 1.24)	0.108	1.10 (0.97, 1.24)	0.137
	Asian	0.96 (0.81, 1.14)	0.661	0.97 (0.82, 1.15)	0.748	1.05 (0.88, 1.26)	0.578	1.02 (0.85, 1.22)	0.856
	Other	0.89 (0.66, 1.20)	0.446	0.88 (0.65, 1.20)	0.436	0.95 (0.69, 1.29)	0.724	0.93 (0.69, 1.26)	0.648
	White	Reference		Reference		Reference		Reference	
30-Day Heart Failure Readmission	Black	1.13 (1.01, 1.26)	0.038	1.12 (0.99, 1.26)	0.080	1.08 (0.96, 1.22)	0.192	1.07 (0.95, 1.21)	0.243
	Hispanic	1.23 (1.04, 1.46)	0.014	1.20 (1.02, 1.41)	0.031	1.19 (1.00, 1.41)	0.046	1.20 (1.00, 1.44)	0.044
	Asian	0.90 (0.72, 1.13)	0.359	0.92 (0.74, 1.16)	0.485	1.03 (0.80, 1.32)	0.808	0.98 (0.77, 1.25)	0.869
	Other	0.89 (0.62, 1.27)	0.522	0.89 (0.63, 1.26)	0.513	0.97 (0.68, 1.37)	0.849	0.95 (0.67, 1.34)	0.778
	White	Reference		Reference		Reference		Reference	
30-Day Composite of Mortality/Readmission	Black	1.05 (0.99, 1.10)	0.109	1.08 (1.02, 1.15)	0.010	1.07 (1.00, 1.13)	0.047	1.06 (0.99, 1.12)	0.083
	Hispanic	1.05 (0.94, 1.18)	0.349	1.08 (0.97, 1.21)	0.171	1.08 (0.96, 1.20)	0.190	1.05 (0.94, 1.17)	0.387
	Asian	0.85 (0.74, 0.96)	0.011	0.87 (0.76, 0.99)	0.033	0.92 (0.81, 1.06)	0.256	0.91 (0.79, 1.04)	0.165
	Other	0.96 (0.78, 1.20)	0.746	0.98 (0.80, 1.21)	0.864	1.03 (0.83, 1.27)	0.818	1.02 (0.83, 1.25)	0.867
	White	Reference		Reference		Reference		Reference	

Outcomes	Race/Ethnic Groups	Unadjusted		Model 1		Model 2		Model 3	
		HR (95% CI)	P-value	HR (95% CI)	P-value	HR (95% CI)	P-value	HR (95% CI)	P-value
1-Year Mortality	Black	0.76 (0.70, 0.82)	<.001	0.93 (0.86, 0.99)	0.034	0.92 (0.86, 0.99)	0.021	0.93 (0.87, 0.99)	0.031
	Hispanic	0.72 (0.64, 0.80)	<.001	0.83 (0.75, 0.91)	<.001	0.82 (0.74, 0.90)	<.001	0.83 (0.75, 0.91)	<.001
	Asian	0.71 (0.62, 0.82)	<.001	0.75 (0.65, 0.86)	<.001	0.75 (0.66, 0.86)	<.001	0.76 (0.66, 0.88)	<.001
	Other	0.83 (0.70, 0.98)	0.031	0.99 (0.85, 1.14)	0.856	0.99 (0.85, 1.16)	0.948	1.00 (0.86, 1.16)	0.982
	White	Reference		Reference		Reference		Reference	
1-Year All-Cause Readmission	Black	1.16 (1.11, 1.22)	<.001	1.17 (1.11, 1.22)	<.001	1.16 (1.10, 1.22)	<.001	1.14 (1.09, 1.20)	<.001
	Hispanic	1.08 (0.98, 1.18)	0.114	1.08 (0.98, 1.19)	0.115	1.08 (0.99, 1.18)	0.097	1.05 (0.97, 1.14)	0.209
	Asian	0.89 (0.83, 0.96)	0.003	0.91 (0.85, 0.98)	0.013	0.98 (0.90, 1.06)	0.598	0.94 (0.87, 1.02)	0.139
	Other	1.03 (0.88, 1.21)	0.713	1.04 (0.90, 1.20)	0.639	1.10 (0.96, 1.25)	0.173	1.08 (0.95, 1.23)	0.229
	White	Reference		Reference		Reference		Reference	
1-Year Cardiovascular Readmission	Black	1.25 (1.18, 1.33)	<.001	1.26 (1.18, 1.34)	<.001	1.24 (1.17, 1.33)	<.001	1.22 (1.15, 1.30)	<.001
	Hispanic	1.17 (1.08, 1.26)	<.001	1.16 (1.07, 1.25)	<.001	1.15 (1.08, 1.24)	<.001	1.12 (1.04, 1.21)	0.003
	Asian	0.94 (0.82, 1.07)	0.332	0.96 (0.84, 1.09)	0.498	1.03 (0.90, 1.19)	0.654	0.99 (0.86, 1.13)	0.842
	Other	0.96 (0.82, 1.13)	0.625	0.96 (0.82, 1.13)	0.650	1.02 (0.87, 1.21)	0.777	1.01 (0.86, 1.18)	0.921
	White	Reference		Reference		Reference		Reference	
1-Year Heart Failure Readmission	Black	1.23 (1.15, 1.32)	<.001	1.26 (1.17, 1.35)	<.001	1.24 (1.15, 1.33)	<.001	1.21 (1.13, 1.30)	<.001
	Hispanic	1.15 (1.04, 1.27)	0.005	1.15 (1.04, 1.27)	0.006	1.14 (1.03, 1.26)	0.010	1.10 (0.99, 1.23)	0.080
	Asian	0.92 (0.79, 1.06)	0.254	0.93 (0.81, 1.08)	0.358	1.02 (0.86, 1.20)	0.851	0.97 (0.82, 1.14)	0.715
	Other	1.00 (0.81, 1.24)	0.965	1.02 (0.82, 1.27)	0.843	1.10 (0.89, 1.35)	0.388	1.08 (0.88, 1.32)	0.466
	White	Reference		Reference		Reference		Reference	
1-Year Composite of Mortality/Readmission	Black	1.10 (1.05, 1.14)	<.001	1.14 (1.08, 1.19)	<.001	1.13 (1.07, 1.18)	<.001	1.12 (1.07, 1.17)	<.001
	Hispanic	1.02 (0.93, 1.11)	0.697	1.04 (0.96, 1.14)	0.340	1.04 (0.96, 1.13)	0.340	1.03 (0.95, 1.11)	0.507
	Asian	0.87 (0.81, 0.93)	<.001	0.89 (0.83, 0.96)	0.003	0.94 (0.87, 1.02)	0.145	0.92 (0.85, 1.00)	0.038
	Other	1.02 (0.87, 1.19)	0.848	1.05 (0.92, 1.20)	0.506	1.09 (0.96, 1.24)	0.164	1.08 (0.96, 1.23)	0.209
	White	Reference		Reference		Reference		Reference	

Legend: Model 1 adjusts for patient characteristics only, model 2 adjusts for patient and hospital characteristics, model 3 adjusts for patient, hospital characteristics and regional SES variables based on patient zip code. CI = confidence interval, HR = hazard ratio

Figure 1. Cumulative incidence plots for one-year mortality and readmission outcomes stratified by race/ethnic groups.

A   **B**

E

One Year Composite of Mortality/Readmission
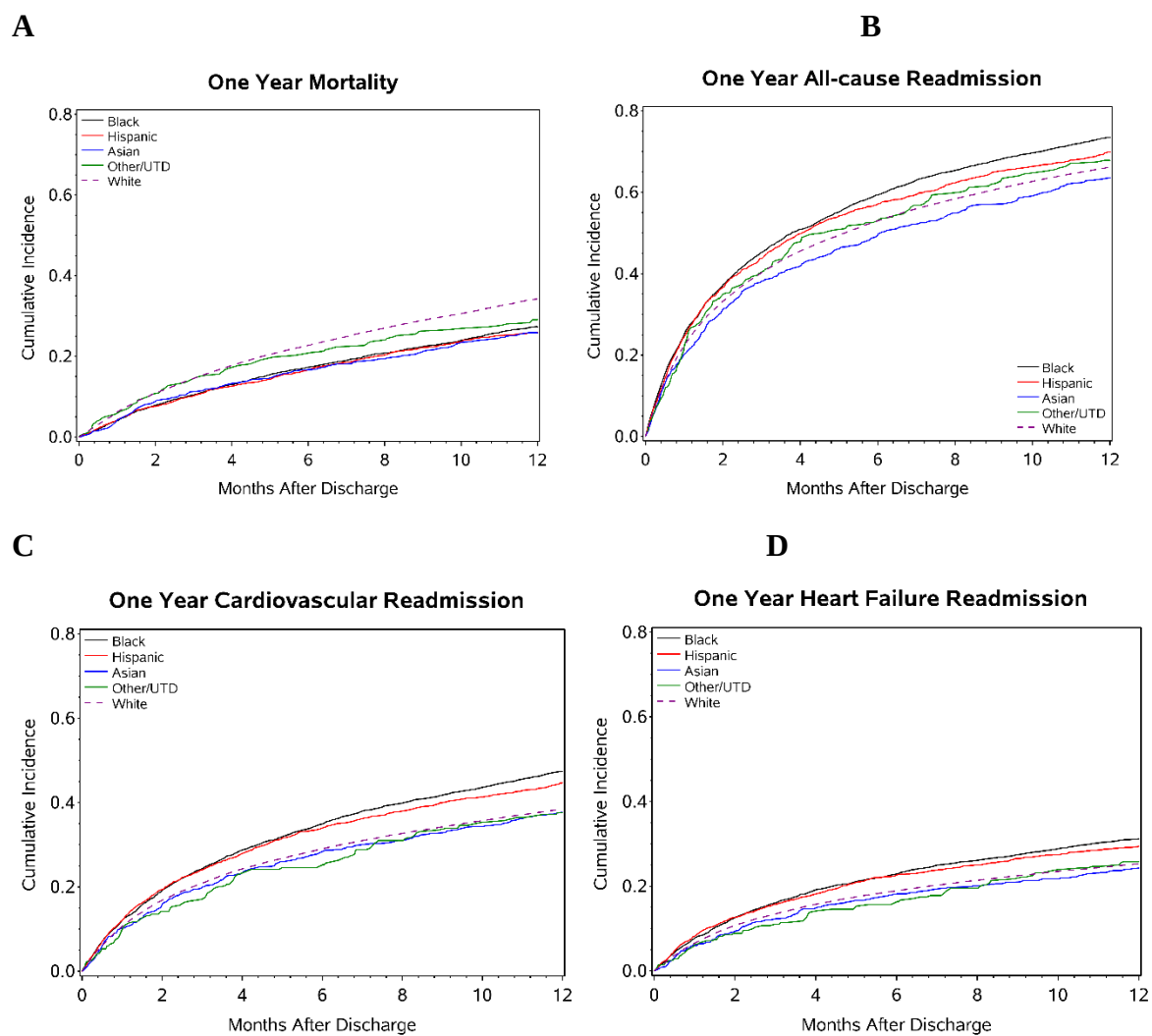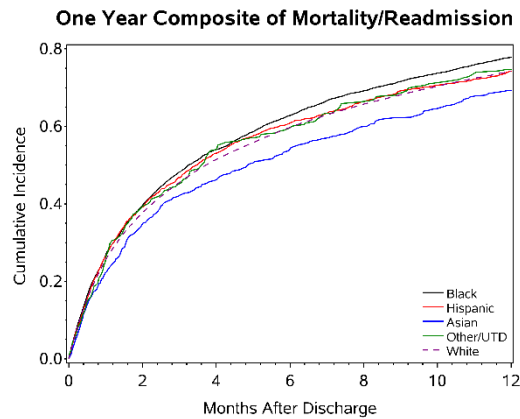
Legend: Cumulative incidence plots for (A) 1-year mortality white=34.26%, black=27.35%, Hispanic=25.98%, Asian=25.87%, (B) 1-year all-cause readmission white=66.15%, black=73.49%, Hispanic=69.89%, Asian=63.54%, (C) 1-year cardiovascular readmission white=38.40%, black=47.40%, Hispanic=44.72%, Asian=37.68%, (D) 1-year heart failure readmission white=25.28%, black=31.19%, Hispanic=29.42%, Asian=24.27%, and (E) 1-year composite of mortality and readmission white=74.21%, black=77.82%, Hispanic=74.18%, Asian=69.33%

Supplemental Material

Table I: Covariates used in the Cox proportional hazard model to adjust for patient characteristics.

Factors	Covariates
Demographics	Age, gender
Medical History	Anemia, ischemic etiology, CVA/TIA, diabetes (insulin and non-insulin treated), hyperlipidemia, hypertension, COPD or Asthma, PVD, renal insufficiency, smoking
Exam and Labs	LVEF, SBP at admission, pulse, BUN

Table II: Covariates used in the Cox proportional hazard model to adjust for hospital characteristics.

Covariates	Values
Geographic Region	West, Midwest, South, Northeast
Hospital Type	Teaching/non-teaching
Number of beds	Continuous; Median (IQR) = 348 (227,527)
Location	Rural or urban

Table III: Socioeconomic status variables obtained through Area Health Resource File linkage used for adjustment in the Cox proportional hazard model.

SES Variables	Available data	Problem	Proposed solutions
Median household income estimate	2000-2013, census each year	Missing 2014 data.	Assigned 2013 values to patients admitted in 2014.
Median home value	2000 census 2006-10 census 2009-13 census	The 2006-2010 census and 2009-2013 census overlapped on years 2009 and 2010.	Assigned values from 2006-10 census data to patients admitted between 2006 and 2009; Assigned values from 2009-13 census data to patients admitted between 2010 and 2014.
% persons 25+ w/ HS diploma or more	2006-10 census 2009-13 census		
% persons 25+ w/ 4+ years college	2006-10 census 2009-13 census		

Table IV: Rate of missingness and imputation procedures for Cox proportional hazard models.

Variables	% Missing	Imputation
Table 1 variables		
Demographics		
Age*	0	n/a
Age (Categorical)*	0	
Female	0	n/a
Insurance Status	17.29	
Medical History	0	n/a
Medical History - Smoking	0.81	Imputed to No
Vitals on Admission		
Heart Rate (30-200), bpm*	17.65	Multiple imputation
SBP (50-250), mmHg*	17.51	Multiple imputation
DBP (20-200), mmHg*	17.42	
BMI (13-100)*	43.79	
Lab Measures		
LVEF Source	0	
EF, %*	8.69	Multiple imputation
Serum creatinine, mg/dL*	28.52	
Serum sodium mEq/L,*	45.78	
BUN, mg/dL*	45.60	Multiple imputation
BNP, Admission pg/mL*	58.10	
Hemoglobin, g/dL*	48.84	
HbA1C (0-20), %*	90.45	
Total Cholesterol (10-1000), mg/dL*	80.24	
HDL (0-120), mg/dL*	80.72	
LDL (30-500), mg/dL*	80.56	
Triglycerides (5-2000), mg/dL*	80.60	
Admission Medications	37.15	
Admission Medications - Diabetic Meds (Any)	36.86	
Year of index admission	0	
Hospital Characteristics		
Hospital Size (Number of Beds)*	0.27	Not imputed
Geographic Region	0	n/a
Rural Location	0.22	Not imputed
Teaching Status	0.48	Not imputed
Heart Transplants Performed at Site	15.30	
Table 2 variables		
In-Hospital Procedures	32.35	
Discharge Medications		
ACEi	6.11	
ARB	6.33	
Anticoagulation therapy	8.19	
Beta-blocker	3.87	
Aldosterone Antagonist	9.76	
Diabetic Tx	53.49	
Lipid Lowering medications	32.12	
Hydralazine Nitrate	10.99	
Diuretic	3.28	
In-hospital outcomes		
In-hospital death	0	
LOS	19.88	

* Shaded variates are model covariates

Table V: Screening criteria for final observational cohort.

		N Patients	N Sites	% Remained
1.	Starting Population:			
	1) Heart failure hospitalizations from fully-participating hospitals in GWTG-HF discharged between Jan 1, 2006 and Dec 1, 2014	361,598	447	
	2) Age 65-year-old or older	258,166	444	71.40
	3) Linked to 2006-2014 Medicare inpatient claims with first admission	124,168	418	48.10
	4) Eligible for CMS Part A&B FFS during CMS discharge month	119,318†	416	96.09
2.	Exclusion Criteria:	(excluded)	(excluded)	
	1) Patients with unknown or missing race/ethnicity	(6)	(0)	99.99
	2) Patients transferred out/discharged to hospice care/left AMA/disposition UTD/missing	(7,426)	(0)	93.78
	3) Patients not linked to valid SES information	(399)	(3)	99.64
	4) LVEF missing	(4,226)	(3)	96.21
	5) LVEF <50%	(54,196)	(7)	49.47
3.	Population Remained:	53,065‡	403	

† 5,068 patients had race/ethnicity missing and were imputed from CMS race/ethnicity classification.

‡ 53,065 patients from 403 sites were discharged between January 1, 2006 and December 1, 2014; among which 51,543 (97.13%) patients were discharged alive to allow 30-day follow-up to December 31, 2014

44,497 patients from 370 sites were discharged between January 1, 2006 and December 31, 2013; among which 43,212 (97.11%) patients were discharged alive to allow 1-year follow-up to December 31, 2014

Table VI: Race/ethnic groups in starting population (N=119,318).

Available Race/Ethnic Options	#	%	Description/Categorized as:
5 = White	95,324	79.89	Non-Hispanic White
4 = Black	11,284	9.46	Non-Hispanic Black
3 = Hispanic (Any Race)	5,619	4.71	Hispanic ethnicity, any race
2 = Asian	1,521	1.27	Non-Hispanic Asian
1 = Other/UTD	3,287	2.75	Other
Native Hawaiian or Pacific Islander	223		(Other)
American Indian or Alaska Native	279		(Other)
Unable to determine (UTD)	2,785		(Other)
. = Missing	2,283	1.91	Excluded
Total	119,318	100	

Table VII: CMS race/ethnicity composition of the 5,068 patients with GWTG race UTD/missing.

CMS race group	#	%	UTD/Missing in GWTG-HF	Description/Categorized as:
1=WHITE	4,236	83.58	UTD/Missing	White
2=BLACK	300	5.92	UTD/Missing	Black
5=HISPANIC	117	2.31	UTD/Missing	Hispanic
4=ASIAN	165	3.26	UTD/Missing	Asian
6=NORTH AMERICAN NATIVE	10	0.20	Missing	Other
3=OTHER	12	0.24	Missing	Other
7=Unknown	6	0.12	Missing	**Exclude**
3 or 6	207	4.08	UTD	Other, unchanged
7=Unknown	15	0.30	UTD	Other, unchanged
GWTG race UTD/Missing after step 4 (CMS linked and FFS eligible patients, N=119,318)	5,068	100		

Table VIII: LVEF categorization by race/ethnicity in the starting population (N=119,318).

LVEF Groups/Race (N, %)	White	Black	Hispanic	Asian	Other	Missing	Total Cohort
HFrEF, Reduced	34,704	4,896	2,182	522	281	3	42,588
	34.86%	42.27%	38.04%	30.96%	37.67%	50.00%	35.69%
HFbEF, Borderline	13,217	1,364	756	222	93	1	15,653
	13.28%	11.77%	13.18%	13.17%	12.47%	16.67%	13.12%
HFpEF, Preserved	47,424	4,945	2,472	883	339	0	56,063
	47.63%	42.69%	43.10%	52.37%	45.44%	0.00%	46.99%
Missing	4,215	379	326	59	33	2	5,014
	4.23%	3.27%	5.68%	3.50%	4.42%	33.33%	4.2%
Total	99,560	11,584	5,736	1,686	746	6	119,318

Table IX: Cumulative incidence of follow-up outcomes at 1 year by race/ethnicity, stratified by age groups.

Outcomes	Race	Age ≥80y	Age 79-75	Age 70-74	Age 65-69
		N events (CIF, %)	N events (CIF, %)	N events (CIF, %)	N events (CIF, %)
1y mortality		<.0001	0.1312	0.0013	0.1045
	White	9,083 (39.63)	1,576 (27.49)	1,071 (24.68)	735 (21.71)
	Black	564 (35.12)	191 (24.93)	179 (22.04)	161 (19.66)
	Hispanic	287 (32.84)	76 (21.84)	56 (18.01)	57 (19.06)
	Asian	126 (30.43)	35 (26.32)	11 (12.64)	13 (16.05)
	Other	43 (34.96)	16 (30.19)	18 (32.14)	5 (10.00)
1y all-cause readmission		<.0001	0.0006	0.0176	0.0944
	White	14,836 (65.24)	3,859 (68.03)	2,893 (67.60)	2,242 (67.28)
	Black	1,170 (73.98)	548 (73.20)	581 (73.66)	572 (72.60)
	Hispanic	604 (70.20)	243 (71.49)	202 (66.69)	205 (70.26)
	Asian	259 (63.10)	92 (69.60)	52 (61.24)	46 (58.02)
	Other	76 (62.30)	41 (78.83)	38 (67.86)	34 (70.24)
1y CV readmission		<.0001	<.0001	<.0001	0.1479
	White	8,607 (37.87)	2,234 (39.40)	1,648 (38.57)	1,336 (40.11)
	Black	731 (46.25)	370 (49.48)	384 (48.88)	363 (46.29)
	Hispanic	373 (43.49)	155 (45.69)	148 (49.11)	123 (42.54)
	Asian	142 (34.63)	59 (44.60)	35 (41.23)	30 (38.24)
	Other	46 (37.40)	21 (40.35)	19 (33.93)	19 (39.01)
1y HF readmission		<.0001	<.0001	<.0001	0.0191
	White	5,862 (25.80)	1,375 (24.24)	1,033 (24.18)	830 (24.93)
	Black	490 (30.99)	241 (32.23)	240 (30.49)	246 (31.33)
	Hispanic	247 (28.80)	101 (29.70)	105 (34.96)	73 (25.13)
	Asian	91 (22.23)	35 (26.46)	23 (27.01)	22 (28.38)
	Other	30 (24.39)	17 (32.68)	11 (19.64)	14 (28.78)
1y composite of mortality or readmission		<.0001	0.0021	0.0128	0.0910
	White	17,201 (75.58)	4,120 (72.59)	3,062 (71.50)	2,371 (71.07)
	Black	1,267 (80.05)	577 (77.07)	603 (76.42)	595 (75.43)
	Hispanic	656 (76.12)	254 (74.75)	211 (69.68)	211 (72.31)
	Asian	292 (71.11)	100 (75.68)	52 (61.24)	46 (58.02)
	Other	89 (72.36)	43 (82.64)	42 (75.00)	35 (72.24)

Note: Log-rank p is presented for 1y mortality; Gray's p is presented for other outcomes.