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Medicare Expenditures by Race/Ethnicity After Hospitalization for Heart Failure With Preserved Ejection Fraction

Boback Ziaeian, MD, PhD,[a,b] Paul A. Heidenreich, MD, MS,[c] Haolin Xu, MS,[d] Adam D. DeVore, MD, MHS,[d,e] Roland A. Matsouaka, PhD,[d,f] Adrian F. Hernandez, MD, MHS,[d] Deepak L. Bhatt, MD, MPH,[g] Clyde W. Yancy, MD,[h] Gregg C. Fonarow, MD[i]

ABSTRACT

OBJECTIVES The purpose of this study was to analyze cumulative Medicare expenditures at index admission and after discharge by race or ethnicity.

BACKGROUND Heart failure with preserved ejection fraction (HFpEF) is a growing proportion of heart failure (HF) admissions. Research on health care expenditures for patients with HFpEF is limited.

METHODS Records of patients discharged from the Get With The Guidelines-Heart Failure registry between 2006 and 2014 were linked to Medicare data. The primary outcome was unadjusted payments for acute care services. Comparisons between race/ethnic groups were made using generalized linear mixed models. Cost ratios were reported by race/ethnicity, and adjustments were made sequentially for patient characteristics, hospital factors, and regional socioeconomic status.

RESULTS Median Medicare costs for index hospitalizations were $7,241 for the entire cohort, $7,049 for whites, $8,269 for blacks, $8,808 for Hispanics, $8,477 for Asians, and $8,963 for other races. Median costs at 30 days for readmitted patients were $9,803 and $17,456 for the entire cohort at 1-year. No significant differences were seen in index admission cost ratios by race/ethnicity. At 30 days among readmitted patients, costs were 9% higher (95% confidence interval [CI]: 1% to 17%; $p = 0.020$) for blacks in the fully adjusted model than whites. At 1 year, costs were 14% higher (95% CI: 9% to 18%; $p < 0.001$) for blacks, 7% higher (95% CI: 0% to 14%; $p = 0.041$) for Hispanics, and 24% higher (95% CI: 8% to 42%; $p = 0.003$) for patients of other races. No significant differences between white and Asian expenditures were noted.

CONCLUSIONS Minority patients with HFpEF have greater acute care service costs. Further research of improving care delivery is needed to reduce acute care use for vulnerable populations. (J Am Coll Cardiol HF 2018;6:388–97)

From the [a]Division of Cardiology, David Geffen School of Medicine at University of California, Los Angeles, Los Angeles, California; [b]Division of Cardiology, Veterans Affairs Greater Los Angeles Healthcare System, Los Angeles, California; [c]Division of Cardiology, Veterans Affairs Palo Alto Healthcare System, Palo Alto, California; [d]Duke Clinical Research Institute, Durham, North Carolina; [e]Division of Cardiology, Duke University Medical Center, Durham, North Carolina; [f]Department of Biostatistics and Bioinformatics, Duke University, Durham, North Carolina; [g]Heart and Vascular Center, Brigham and Women's Hospital and Harvard Medical School, Boston, Massachusetts; [h]Division of Cardiology, Northwestern University, Chicago, Illinois; and the [i]Ahmanson-UCLA Cardiomyopathy Center, University of California, Los Angeles Medical Center, Los Angeles, California.
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Direct medical costs for heart failure (HF) were estimated at $28.5 billion with an average growth rate of 1.1% per year in the United States for 2013 (1). An estimated 6.5 million American adults had HF between 2011 and 2014, based on self-reported data from the National Health and Nutrition Examination Survey (2). By 2030, the prevalence of HF was expected to increase to over 8 million people secondary to shifting age demographics (3). HF prevalence among Medicare beneficiaries was 13.5% in 2015 (4). Medicare Parts A and B combined spending averaged $28,963 per HF beneficiary and was the second most expensive chronic condition behind stroke in 2015 (5). Although improvements in the prevention and treatment of ischemic heart disease have lowered the age-standardized rates of HF with reduced ejection fraction (HFrEF), the proportion of patients with HF with preserved ejection fraction (HFpEF) continues to grow (6,7).

SEE PAGE 398

Relatively few studies have been peformed which have evaluated health care use and expenditures associated with HFpEF. Patients with HFpEF have an observed lower mortality rate but higher readmission rate than HFrEF patients (8). With respect to race/ethnicity, black patients with HFpEF have a higher risk of readmission at 30 days and 1 year when adjusting for patient characteristics, socioeconomic status (SES), and hospital factors (9). Furthermore, SES may also influence health care use. How the uses of health care for patients with HFpEF may differ based on race/ethnicity and SES status are not well described. This study reports differences in Medicare inpatient expenditures by race/ethnicity, using the Get With The Guidelines-Heart Failure (GWTG-HF) registry linked to the Centers for Medicare and Medicaid Services administrative data.

ABBREVIATIONS AND ACRONYMS

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

SES = socioeconomic status

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 were identified by medical providers based on clinically diagnosed HF. Inclusion in the final cohort required age ≥65, eligibility for Medicare Parts A and B fee-for-service benefit during the discharge month, and left ventricular ejection fraction (LVEF) ≥50% on quantitative assessment; or if quantitative LVEF was not available, qualitative assessment of normal or mild dysfunction was included. LVEF criteria were consistent with society guideline definitions (10,11). Patients were excluded if disposition indicated transfer to a hospice facility, or they left against medical advice, or disposition was unknown. Patients were also excluded if regional SES variables were not available. The GWTG-HF registry was linked to Centers for Medicare and Medicaid Services administrative claims data providing use of services, expenditures, and outcomes at index admission and post-discharge.

STATISTICAL ANALYSIS. Baseline patient and hospital characteristics were described by race/ethnic groups. Patient factors included age, sex, medical history, vital signs, body mass index, laboratory test values (i.e., blood urea nitrogen, serum creatinine, serum sodium, hemoglobin, hemoglobin A_{1c}, and lipid panel). Hospital characteristics included region, rural location, teaching status, and size (number of beds). Percentages and median interquartile ranges were reported for categorical and continuous

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TABLE 1 Baseline Patient and Hospital Characteristics for Overall Patients With HFpEF and by Race/Ethnic Groups

	White (n = 44,871)	Black (n = 4,767)	Hispanic (n = 2,260)	Asian (n = 842)	Other (n = 325)	Overall (N = 53,065)	p Value	Standardized Difference White vs. Black	Hispanic	Asian	Other
Demographics											
Age, yrs	83 (76–88)	77 (71–84)	79 (72–85)	81 (75–87)	77 (71–83)	82 (75–88)	<0.0001	52.1	34.6	13.4	51.7
Categorical age, yrs							<0.0001				
65–69	9.26	20.54	16.02	11.64	17.54	10.65		32.1	20.4	7.8	24.5
70–74	11.79	19.93	16.46	11.28	19.69	12.76		22.4	13.4	1.6	21.8
75–79	15.56	19.13	18.58	19.95	18.77	16.10		9.4	8.0	11.5	8.5
≥80	63.39	40.40	48.94	57.13	44.00	60.49		47.3	29.4	12.8	39.6
Women	65.75	70.40	68.32	62.47	68.31	66.24	<0.0001	10.0	5.5	6.8	5.5
Medical history											
Hypertension	80.22	89.76	84.73	82.74	78.86	81.29	<0.0001	27.0	11.9	6.5	3.4
CAD	45.33	37.26	44.44	41.24	45.30	44.51	<0.0001	16.5	1.8	8.3	0.1
Prior MI	13.41	11.29	11.30	9.77	12.42	13.07	<0.0001	6.4	6.4	11.4	3.0
Atrial flutter/ fibrillation	47.33	25.33	25.44	31.85	32.55	44.12	<0.0001	47.0	46.7	32.0	30.5
Hyperlipidemia	49.26	47.22	48.84	49.11	47.32	49.05	0.1314	4.1	0.8	0.3	3.9
Peripheral vascular disease	12.75	11.70	11.87	5.46	11.07	12.49	<0.0001	3.2	2.7	25.6	5.2
Diabetes (insulin or noninsulin treated)	36.36	56.38	56.03	43.91	50.00	39.17	<0.0001	41.0	40.2	15.4	27.8
CVA/TIA	16.70	19.82	15.18	16.12	12.42	16.88	<0.0001	8.1	4.2	1.6	12.2
COPD or asthma	31.76	32.73	28.51	22.34	28.86	31.54	<0.0001	2.1	7.1	21.3	6.3
ICD only	1.48	1.26	1.09	1.02	1.01	1.43	0.3242	1.9	3.5	4.2	4.2
Anemia	21.93	26.25	20.57	18.78	24.16	22.22	<0.0001	10.1	3.3	7.8	5.3
Dialysis (chronic)	2.21	8.82	8.09	9.26	8.05	3.19	<0.0001	29.3	26.8	30.7	26.7
Chronic renal insufficiency, SCr >2.0, mg/dl	19.14	30.42	24.21	24.75	25.17	20.48	<0.0001	26.3	12.3	13.6	14.6
Depression	12.73	7.02	10.26	5.20	7.38	11.97	<0.0001	19.2	7.7	26.6	17.8
Ischemic cause: history of CAD, MI, prior PCI, prior CABG, or prior PCI/CABG	50.23	41.26	49.93	45.18	49.66	49.34	<0.0001	18.1	0.6	10.1	1.1
History panel missing	5.50	6.75	6.42	6.41	8.31	5.69	0.0005	5.2	3.9	3.8	11.1
Smoking	6.64	10.05	6.75	4.32	7.17	6.92	<0.0001	12.4	0.4	10.2	2.1
Medications on admission											
ACE-I	29.41	30.61	29.81	21.50	33.16	29.43	0.0007	2.6	0.9	18.3	8.1
ARB	16.23	19.32	22.57	26.49	23.32	16.98	<0.0001	8.1	16.1	25.2	17.9
Aldosterone antagonist	5.60	5.61	3.80	4.99	4.66	5.51	0.0551	0.0	8.6	2.7	4.3
Aspirin	45.14	40.84	40.10	32.82	53.37	44.40	<0.0001	8.7	10.2	25.5	16.5
Beta-blocker	55.05	54.41	55.21	50.10	54.92	54.93	0.2437	1.3	0.3	9.9	0.3
Diabetic medications (any)	21.56	34.00	36.92	31.36	35.38	23.56	<0.0001	28.1	34.3	22.4	31.0
Anticoagulation therapy	29.61	16.98	14.98	15.36	15.54	27.57	<0.0001	30.2	35.7	34.7	34.1
Diuretic agent	61.87	56.96	52.86	44.15	57.51	60.75	<0.0001	10.0	18.3	36.1	8.9
Hydralazine	5.80	15.01	9.73	6.91	4.66	6.78	<0.0001	30.5	14.7	4.6	5.1
Lipid-lowering agent (any)	54.71	56.89	57.00	55.09	62.69	55.05	0.0166	4.4	4.6	0.8	16.3

Continued on the next page

variables, respectively. The Pearson chi-squared test was used to compare categorical variables, and the Wilcoxon rank-sum test was used to compare ordinal categorical variables or continuous variables. Standardized differences were used to describe significant differences between groups. SES was linked using patients' zip codes, geocoding to the 2015 Area Health Resource File provided through the Health

TABLE 1 Continued

	White (n = 44,871)	Black (n = 4,767)	Hispanic (n = 2,260)	Asian (n = 842)	Other (n = 325)	Overall (N = 53,065)	p Value	Standardized Difference White vs. Black	Hispanic	Asian	Other
Vitals on admission											
Heart rate, beats/min	79 (68–92)	79 (68–91)	78 (68–91)	77 (68–93)	80 (69–92)	79 (68–92)	0.459	0.7	2.5	0.7	3.3
SBP, mm Hg	143 (124–163)	153 (133–178)	149 (130–172)	147 (128–166)	144 (123–162)	144 (125–165)	<0.0001	34.5	21.8	11.8	0.0
DBP, mm Hg	72 (62–83)	76 (66–88)	72 (62–84)	72 (62–84)	73 (63–84)	72 (62–84)	<0.0001	27.1	5.7	2.1	7.8
BMI, kg/m^2	27.46 (23.27–32.95)	30.07 (25.21–36.33)	29.00 (24.61–34.06)	23.84 (21.03–27.55)	29.26 (24.47–34.55)	27.66 (23.43–33.27)	<0.0001	32.0	15.7	56.7	10.8
Laboratory values											
LVEF source							0.0155				
Quantitative LVEF	91.17	92.22	91.55	93.59	90.15	91.31		3.8	1.3	9.1	3.5
Qualitative LVEF	8.83	7.78	8.45	6.41	9.85	8.69		3.8	1.3	9.1	3.5
EF, %	60 (55–64)	60 (55–65)	60 (55–65)	60 (55–65)	60 (55–65)	60 (55–64)	<0.0001	8.2	2.6	13.0	10.0
Serum creatinine, mg/dl	1.2 (0.9–1.7)	1.5 (1.1–2.4)	1.3 (0.9–2.0)	1.3 (0.9–2.1)	1.3 (0.9–2.1)	1.2 (0.9–1.7)	<0.0001	12.7	9.0	10.9	10.2
Serum sodium, mEq/l	138 (135–141)	139 (137–142)	138 (135–140)	137 (134–140)	138 (135–140)	138 (135–141)	<0.0001	10.7	14.1	13.0	5.4
BUN, mg/dl	25 (18–36)	25 (17–39)	25 (18–40)	26 (18–39.5)	25 (17.5–40.5)	25 (18–36)	0.0086	5.7	10.6	13.6	11.1
BNP on admission, pg/ml	560 (304.0–1,020.0)	571 (234.5–1,199.5)	564 (270–1,120)	627 (316–1,140)	598 (275.5–1,120.5)	562 (297–1,038.8)	0.4905	13.0	8.5	7.9	2.9
Hemoglobin, g/dl	11.5 (10.2–12.8)	10.9 (9.6–12.2)	11.3 (9.9–12.5)	11.3 (10–12.7)	10.9 (9.6–12.2)	11.4 (10.1–12.8)	<0.0001	16.8	6.9	0.7	27.4
HbA_{1C} (0–20), %	6.5 (5.9–7.3)	6.6 (5.9–7.6)	6.8 (6.0–7.7)	6.6 (6.0–7.3)	6.5 (6.0–8.4)	6.5 (5.9–7.4)	0.0102	7.8	18.8	1.7	16.6
Total cholesterol (10–1,000), mg/dl	134 (111–161)	142 (118–172)	134 (114–166)	139 (116–166)	121 (102–147)	135 (112–163)	<0.0001	21.4	9.9	15.2	27.9
HDL (0–120), mg/dl	40 (32–51)	46 (36–56)	41 (32–52)	42 (35–52)	40 (32–47)	41 (33–51)	<0.0001	29.9	3.9	14.1	3.3
LDL (30–500), mg/d	72 (55–94)	78 (58–101)	72 (57–97)	74 (59–92)	64 (50–89)	73 (56–94)	<0.0001	18.8	7.4	4.5	20.0
Triglycerides (5–2,000), mg/dl	89 (66–123)	78 (59–110)	95 (70–132)	93 (64–127)	94 (70–126)	88 (65–122)	<0.0001	22.3	12.3	2.7	3.6
Hospital characteristics											
Hospital size, number of beds	348 (222–481)	438 (292–610)	296 (243–438)	330 (217–400)	358 (194–368)	348 (227–527)	<0.0001	44.4	0.8	4.7	18.6
Geographic region							<0.0001				
West	9.73	3.29	17.88	60.81	35.38	10.47		26.3	23.8	126.5	64.5
South	30.40	43.36	41.19	15.20	16.92	31.70		27.1	22.7	36.8	32.1
Midwest	24.13	22.99	8.41	8.79	28.62	23.14		2.7	43.6	42.3	10.2
Northeast	35.74	30.35	32.52	15.20	19.08	34.70		11.5	6.8	48.5	38.0
Rural location	7.42	4.95	1.15	7.15	16.36	6.98	<0.0001	10.3	31.3	1.0	27.9
Teaching status	55.18	72.00	40.53	51.37	74.77	56.13	<0.0001	35.5	29.6	7.6	42.0
Heart transplants performed at site	9.11	12.72	5.16	7.71	5.56	9.22	<0.0001	11.6	15.4	5.0	13.7

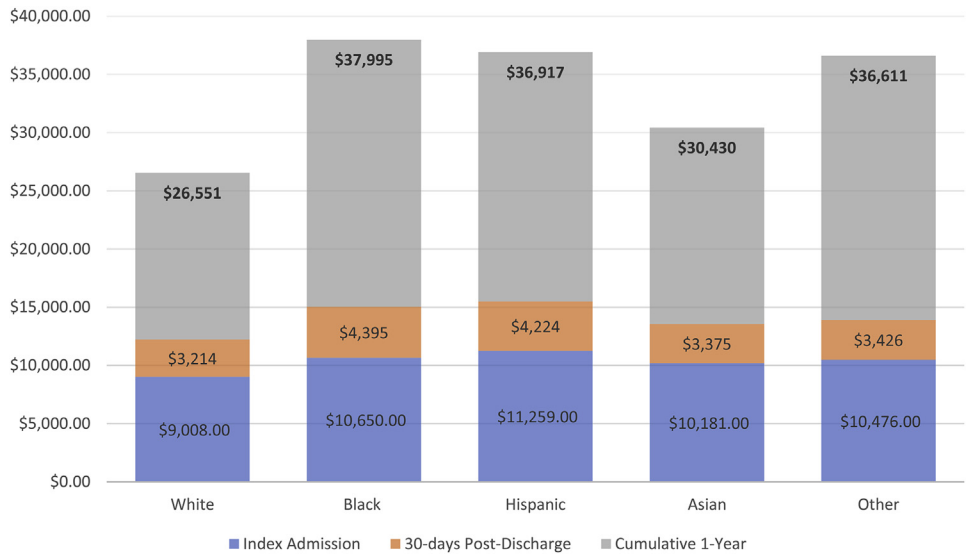
Values are median (interquartile range) or %. Standardized differences are references to those in whites. Standardized differences of ≥10 are clinically meaningful.

ACE-I = angiotensin-converting enzyme inhibitors; ARB = angiotensin II receptor blocker; BMI = body mass index; BNP = B-type natriuretic peptide; BUN = blood urea nitrogen; CABG = coronary artery bypass grafting; CAD = coronary artery disease; COPD = chronic obstructive pulmonary disease; CVA = cerebrovascular accident; DBP = diastolic blood pressure; HbA_{1C} = hemoglobin A_{1C}; HDL = high-density lipoprotein; ICD = implantable cardioverter defibrillator; LDL = low-density lipoprotein; LVEF = left ventricular ejection fraction; MI = myocardial infarction; PCI = percutaneous coronary intervention; SBP = systolic blood pressure; SCr = serum creatinine; TIA = transient ischemic attack.

Resources and Services Administration (12). SES variables included median household income, median home values, percentages of patients with high school diplomas, and percentage with ≥4 years of college (13). Patients' SES variables were assigned values from census data of the year closest to the patients' year of admission.

Primary outcomes included unadjusted Medicare (Part A) inpatient payments at index hospitalization, at 30 days, and at 1 year. Costs were standardized to 2014 dollars by using the Personal Health Care Hospital Care Index (14). Comparisons of health care use were modeled using generalized linear mixed models with a log link function and robust Poisson error distribution to allow for over-dispersion. Hospital-level random intercepts were used to account for clustering of patients within hospitals. Cost ratios were reported by race/ethnic classification

FIGURE 1 Mean Cumulative Unadjusted Costs at 1 Year for Patients With HFpEF by Race/Ethnicity



HFpEF = heart failure with preserved ejection fraction.

controlling for relevant covariates. Secondary outcomes included the proportional change in variance for 1-year Medicare health care expenditures within the mixed models (15). Models were adjusted sequentially for patient and hospital characteristics, followed by patient SES based on zip code (Online Tables 1 to 3). Control variables were selected based on a review of published reports and prior established models used in GWTG-HF (8,13,16). Cumulative costs at 1 year were averaged over the number of patients at risk and accounting for the competing risk of death and differential length of time observed. Medical conditions coded as missing were imput to not present. Patient covariates with missingness were imputed for generalized linear mixed models (Online Table 4). Multiple imputations with 25 datasets were used to impute other patient covariates. Hospital characteristics were not imputed. Analyses were performed in SAS version version 9.4 software (SAS Institute, Inc., Cary, North Carolina).

RESULTS

The final cohort included 53,065 beneficiaries (Online Tables 5 to 8). The median age of hospitalization was 83 years for whites, 77 years for blacks, 79 years for Hispanics, and 81 years for Asians (**Table 1**). A higher proportion of women was observed among blacks than among other race/ethnic groups. Additional stratified analyses by sex were made available (Online Tables 9 to 11). Black and Hispanic patients had lower rates of atrial fibrillation than the other race/ethnic groups. Black and Hispanic patients had higher rates of hypertension, diabetes, and median body mass index. Among black, Hispanic, and Asian patients, chronic renal disease and dialysis were more common. Systolic blood pressure was highest among black patients, followed by Hispanic and Asian patients. LVEF rates were similar among the racial/ethnic groups. More black patients were admitted to teaching hospitals.

Median Medicare Part A costs for index hospitalization were $7,241 for the entire cohort, $7,049 for whites, $8,269 for blacks, $8,808 for Hispanics, $8,477 for Asians, and $8,963 for other race (**Figure 1, Table 2**). Minorities overall had higher hospitalization costs for the index admission. Median costs at 30 days for readmitted patients were $9,803 and $17,456 at 1 year for the entire cohort. Medicare costs among minority patients at index, at 30 days, and at 1 year were higher. Unadjusted cumulative average Medicare costs by race/ethnicity are shown in **Figure 2**.

After adjustments for patient characteristics, hospital factors, and regional SES, cost ratios for the index admission were not considerably different based on race/ethnicity across all models (**Table 3**).

TABLE 2 Total Medicare Part A Costs in 2014 Dollars

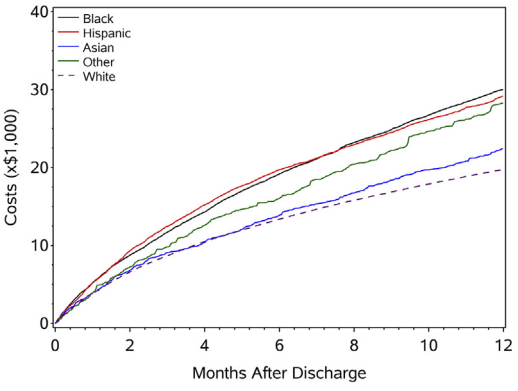
Costs	Overall (N = 53,065)	White (n = 44,871)	Black (n = 4,767)	Hispanic (n = 2,260)	Asian (n = 842)	Other (n = 325)	p Value	% Std. Diff. vs White			
								Black	Hispanic	Asian	Other
All patients											
Index admission							<0.0001	14.9	21.2	12.3	15.7
Median	$7,241	$7,049	$8,269	$8,808	$8,477	$8,963					
Mean	$9,279	$9,008	$10,650	$11,259	$10,181	$10,476					
±SD	$10,050	$9,722	$12,157	$11,400	$9,286	$8,898					
90th percentile	$14,259	$13,654	$17,236	$17,542	$14,719	$15,331					
99th percentile	$47,143	$45,788	$52,390	$56,791	$47,982	$51,115					
Patients discharged alive and with follow-up data											
At 30 days	(N = 51,543)	(n = 43,521)	(n = 4,686)	(n = 2,208)	(n = 813)	(n = 315)	<0.0001	9.3	8.6	1.4	2.2
Median	$0	$0	$0	$0	$0	$0					
Mean	$3,368	$3,214	$4,395	$4,224	$3,375	$3,426					
±SD	$10,865	$10,210	$14,754	$13,102	$12,002	$8,795					
90th percentile	$10,671	$10,265	$13,423	$13,007	$10,789	$12,325					
99th percentile	$45,526	$43,563	$53,418	$54,126	$48,845	$44,896					
At 1 yr	(N = 43,212)	(n = 36,380)	(n = 4,003)	(n = 1,832)	(n = 715)	(n = 282)	<0.0001	27.3	25.1	9.2	23.2
Median	$9,065	$8,544	$13,105	$12,250	$9,055	$13,418					
Mean	$19,048	$17,683	$27,529	$25,948	$20,635	$26,030					
±SD	$30,895	$28,632	$42,118	$36,778	$35,309	$42,044					
90th percentile	$50,120	$46,435	$70,563	$71,026	$52,799	$66,771					
99th percentile	$144,885	$131,656	$201,000	$167,371	$177,330	$198,913					
Cumulative 1 yr	(N = 43,212)	(n = 36,380)	(n = 4,003)	(n = 1,832)	(n = 715)	(n = 282)	<0.0001	29.9	29.1	11.4	26.9
Median	$17,663	$16,898	$23,266	$23,292	$18,168	$23,497					
Mean	$28,180	$26,551	$37,995	$36,917	$30,430	$36,611					
±SD	$33,137	$30,772	$44,596	$39,804	$36,914	$43,136					
90th percentile	$62,335	$57,988	$84,220	$85,392	$66,235	$77,571					
99th percentile	$163,171	$150,311	$226,525	$182,913	$193,769	$209,350					
Readmitted patients only											
At 30 days	(N = 11,401)	(n = 9,500)	(n = 1,140)	(n = 536)	(n = 160)	(n = 65)	<0.0001	14.5	14.2	12.7	10.5
Median	$9,803	$9,545	$11,333	$11,485	$10,876	$11,619					
Mean	$14,936	$14,443	$17,603	$17,246	$16,994	$16,035					
±SD	$18,672	$17,418	$25,368	$21,903	$22,345	$12,449					
90th percentile	$29,055	$27,887	$33,503	$33,771	$37,203	$33,386					
99th percentile	$84,955	$82,081	$107,372	$83,174	$105,841	$58,524					
At 1 yr	(N = 28,593)	(n = 23,830)	(n = 2,871)	(n = 1,254)	(n = 449)	(n = 189)	<0.0001	28.7	30.8	16.0	29.5
Median	$17,456	$16,589	$23,179	$24,890	$19,659	$23,865					
Mean	$28,636	$26,859	$38,114	$37,801	$32,607	$38,578					
±SD	$34,130	$31,653	$45,477	$39,079	$39,879	$46,362					
90th percentile	$62,598	$58,587	$85,126	$85,530	$72,867	$74,307					
99th percentile	$168,916	$155,460	$233,052	$182,865	$198,151	$265,895					

Standardized differences are referenced to those in whites. Standardized differences of ≥10 are clinically meaningful. Costs at 30 days and 1 year do not include index admission costs.

At 30 days, Medicare costs were greater for blacks with a 9% (95% confidence interval [CI]: 1% to 17%) higher relative cost than for whites after sequential adjustments across all models. At 1 year, Medicare costs were higher for black, Hispanic, and patients of other races than for whites, which was significant across all models. For blacks, unadjusted costs were 27% higher, and adjusted costs (for patient characteristics, hospital factors, and regional SES) were 14% higher than for whites. For Hispanics, unadjusted costs were 19% higher, and costs after sequential adjustment were 7% to 8% higher. For the other race category, unadjusted costs were 40% higher, and sequentially adjusted costs were 24% to 25% higher. Costs among Asians were not significantly different compared with those of whites across any of the models.

The proportional changes in variance (PCV) from the mixed models with sequential adjustments were used to explain hospital-level variations in Medicare expenditures. For the overall cohort, patient factors explained 14.7% of the variances among hospitals and

FIGURE 2 Cumulative Average Medicare Part A Costs by Race/Ethnic Groups



Costs were summed and divided by the number of patients at risk during a period of observation. Therefore, the competing risk of death is adjusted.

hospital factors added 23.5%, and regional SES 30.4% to the incremental PCV (Table 4). When we evaluated these factors by race/ethnicity, we found that black race and hospital factors contributed less to the observed variations in Medicare expenditures with a larger incremental PCV (57.1%) explained by the addition of regional SES. For Hispanics, both hospital factors and regional SES explained a greater portion of Medicare expenditure variation than patient factors alone.

Rates of acute care service use was higher among minority patients (Table 5). Cumulative length of stay for patients readmitted at 1 year was higher for black, Hispanic, and other patients. Readmission rates at 30 days and at 1 year were also higher for minority patients, along with medical procedure rates.

DISCUSSION

This study describes the differential expenditures for HFpEF for Medicare Part A payments based on race/ethnicity. We found health care costs at 1 year after an index admission were higher among black, Hispanic, and other race patients when adjusting for patient characteristics, hospital factors, and regional SES. On average, at 1-year, Medicare Part A paid $9,846 more per black beneficiary and $8,265 more per Hispanic beneficiary. The higher use of health care for acute care services indicates an opportunity to reduce disparities in patient outcomes by investing in cost-effective, high-value interventions that would

TABLE 3 Ratios of Medicare Part A Costs by Race/Ethnic Groups

	Unadjusted Model		Cluster Adjusted		Model 1		Model 2		Model 3	
Costs	Cost Ratio (95% CI)	p Value	Cost Ratio (95% CI)	p Value	Cost Ratio (95% CI)	p Value	Cost Ratio (95% CI)	p Value	Cost Ratio (95% CI)	p Value
Among all patients										
Index admission										
Black	1.18 (1.15–1.22)	<0.001	1.02 (0.99–1.05)	0.232	0.99 (0.96–1.02)	0.344	0.98 (0.95–1.01)	0.278	0.98 (0.95–1.02)	0.317
Hispanic	1.25 (1.20–1.30)	<0.001	1.04 (0.99–1.09)	0.107	1.01 (0.96–1.05)	0.702	1.01 (0.97–1.06)	0.599	1.01 (0.96–1.05)	0.750
Asian	1.13 (1.05–1.21)	<0.001	0.96 (0.90–1.04)	0.314	0.96 (0.89–1.02)	0.207	0.95 (0.89–1.02)	0.145	0.95 (0.88–1.02)	0.128
Other	1.16 (1.04–1.30)	0.008	1.04 (0.93–1.15)	0.492	1.00 (0.90–1.11)	0.978	0.99 (0.90–1.10)	0.912	0.99 (0.89–1.10)	0.864
White	Reference		Reference		Reference		Reference		Reference	
Among readmitted patients										
At 30 days										
Black	1.22 (1.13–1.31)	<0.001	1.14 (1.06–1.23)	<0.001	1.10 (1.03–1.18)	0.006	1.10 (1.03–1.18)	0.007	1.09 (1.01–1.17)	0.020
Hispanic	1.19 (1.08–1.32)	<0.001	1.09 (0.98–1.21)	0.098	1.05 (0.95–1.16)	0.361	1.06 (0.95–1.17)	0.283	1.01 (0.91–1.13)	0.810
Asian	1.18 (0.98–1.41)	0.080	1.11 (0.93–1.33)	0.237	1.10 (0.92–1.31)	0.287	1.08 (0.91–1.29)	0.371	1.04 (0.87–1.23)	0.701
Other	1.11 (0.83–1.49)	0.484	1.04 (0.79–1.38)	0.781	0.97 (0.74–1.27)	0.836	0.96 (0.73–1.26)	0.767	0.95 (0.72–1.25)	0.715
White	Reference		Reference		Reference		Reference		Reference	
At 1 yr										
Black	1.42 (1.36–1.48)	<0.001	1.27 (1.22–1.33)	<0.001	1.14 (1.10–1.19)	<0.0001	1.14 (1.09–1.19)	<0.001	1.14 (1.09–1.18)	<0.001
Hispanic	1.41 (1.33–1.49)	<0.001	1.19 (1.11–1.27)	<0.001	1.08 (1.01–1.15)	0.018	1.08 (1.02–1.15)	0.015	1.07 (1.00–1.14)	0.041
Asian	1.21 (1.10–1.35)	<0.001	1.11 (0.99–1.23)	0.063	1.08 (0.98–1.19)	0.137	1.07 (0.97–1.19)	0.161	1.06 (0.96–1.17)	0.260
Other	1.44 (1.24–1.66)	<0.001	1.40 (1.21–1.61)	<0.001	1.25 (1.08–1.43)	0.002	1.25 (1.08–1.43)	0.002	1.24 (1.08–1.42)	0.003
White	Reference		Reference		Reference		Reference		Reference	

The unadjusted model did not include hospital random intercepts; all other models included hospital random intercepts. Model 1 was adjusted for patient characteristics only; model 2 was adjusted for patient and hospital characteristics; model 3 was adjusted for patient, hospital characteristics, and regional SES variables based on patient zip code.

CI = confidence interval; p = p value; SES = socioeconomic status.

TABLE 4 Impact of Patient, Hospital, and SES Factors on Hospital Variations in Medicare Expenditures at 1 Year by Race/Ethnic Groups

	Overall		White		Black		Hispanic	
	PCV	Incremental PCV*	PCV	Incremental PCV*	PCV	Incremental PCV*	PCV	Incremental PCV*
Adjusted model 1: patient factors	14.7		−10.2		−1.7		−14.2	
Adjusted model 2: patient and hospital	34.7	23.5	19.0	26.6	10.7	12.2	39.1	46.6
Adjusted model 3: patient, hospital, and SES	54.6	30.4	37.9	23.3	61.7	57.1	67.4	46.5

*Incremental PCV calculates the PCV from the previous model.
PCV = proportional change in variance; other abbreviation as in Table 3.

lower the incidence of HF. Manageable comorbidities such as poorly controlled hypertension, diabetes, chronic kidney disease, and elevated atherosclerotic risk are prevalent among race/ethnic minority populations, and improved treatment may help reduce acute care service use among Medicare beneficiaries (17,18).

Overall health care expenditures are concentrated among patients with chronic conditions. A study of Medicare beneficiaries in the top decile for costs noted a much higher prevalence of HF (44.4%) and a higher representation of black and Hispanic beneficiaries compared with patients in the lower deciles (19). The top decile patients in Medicare consume 73.0% of all the acute care service spending (19). Many of these hospitalizations and emergency department visits may be preventable with improvements in outpatient management. Vulnerable populations such as minorities with HFpEF are observed to be high users of acute care services (9,19). The differential expenditures for minority patients we observed at 30 days and 1 year are primarily driven by higher admission and readmission rates for minority patients (9). Interventions and systems of care tailored to vulnerable populations are needed to decrease the observed disparities in outcomes and use of acute care services.

Medicare is known to spend nearly as much on post-acute care services and readmissions within 30 days of discharge as at initial hospitalizations (20). Between 1994 and 2009, post-acute care service spending doubled for HF (21). In the Olmsted County cohort study, patients with HFpEF were observed to have 23.6% higher lifetime medical costs than HFrEF

TABLE 5 Acute Care Services by Race/Ethnicity Over 1 Year From Index Admission

	Overall (N = 53,065)	White (n = 44,871)	Black (n = 4,767)	Hispanic (n = 2,260)	Asian (n = 842)	Other (n = 325)	p Value	% Standard Difference vs. Whites			
								Black	Hispanic	Asian	Other
Among all patients											
Index LOS	4 (3–7)	4 (3–7)	4 (3–7)	4 (3–7)	4 (2–7)	4 (3–7)	<0.0001	6.2	7.0	9.5	5.1
Among 1-yr follow-up patients											
Readmissions	1 (0–2)	1 (0–2)	1 (0–3)	1 (0–3)	1 (0–2)	1 (0–3)	<0.0001	22.1	19.4	9.0	14.3
Cumulative LOS	5 (0–14)	5 (0–14)	7 (0–20)	6 (0–18)	4 (0–12)	6 (0–18)	<0.0001	24.4	17.3	4.1	17.7
Mean LOS per admission	2 (0–4.1)	2 (0–4)	2.5 (0–5)	2.3 (0–4.7)	1.5 (0–4)	2.3 (0–4.5)	<0.0001	21.9	11.5	3.0	13.9
Among readmitted patients											
Readmissions	2 (1–3)	2 (1–3)	2 (1–4)	2 (1–4)	2 (1–3)	2 (1–4)	<0.0001	20.6	24.1	9.3	19.0
Cumulative LOS	10 (5–20)	10 (5–20)	13 (6–26)	12 (6–26)	9 (4–18)	12 (6–25)	<0.0001	24.6	19.9	2.8	22.4
Mean LOS per admission	3.3 (2–5.3)	3.3 (2–5.2)	3.7 (2.3–6.2)	3.7 (2.1–5.6)	3.3 (2–5.3)	3.6 (2.2–5.5)	<0.0001	20.4	12.0	0.1	18.5
Unadjusted rates											
30-day mortality rate	5.87	6.19	4.05	4.12	4.06	5.71	<0.0001	9.7	9.3	9.7	2.0
30-day readmission rate	22.13	21.84	24.33	24.28	19.68	20.63	<0.0001	5.9	5.8	5.3	3.0
1-yr mortality rate	33.10	34.26	27.35	25.98	25.87	29.08	<0.0001	15.0	18.1	18.4	11.2
1-yr readmission rate	66.21	65.54	71.77	68.50	62.80	67.38	<0.0001	13.5	6.3	5.7	3.9
1-yr any procedures	46.24	44.96	55.08	51.15	45.59	56.03	<0.0001	20.3	12.4	1.3	22.3
1-yr cardiac procedures	24.07	22.39	35.70	29.26	27.41	34.04	<0.0001	29.6	15.7	11.6	26.1
1-yr dialysis	6.76	5.22	15.74	13.70	13.57	14.54	<0.0001	34.8	29.3	28.9	31.6

Values are median (interquartile range) or %. Reported rates are %. Standardized differences are referenced to those in whites. Standardized differences of >10 are clinically meaningful.
LOS = length of stay.

patients when controlling for other comorbidities and patient factors (22). We describe similarly high cost burdens for patients with HFpEF at the year after an index admission, with marked variation with respect to race/ethnicity.

Using sequential adjustments, we have attempted to demonstrate what factors may be driving differences in Medicare expenditures based on race/ethnic classification. We found that among minority groups, regional SES explained greater differences in Medicare expenditures at 1 year than it did among whites. Differences in expenditures adjusted for patient factors alone did not explain much of the variation in Medicare expenditures. This suggests that the disparities we observed based on race/ethnic categorization may largely be driven at the hospital or regional level. Communities in low-SES regions may lack the resources for high-quality acute care services and may be doubly disadvantaged with poor quality outpatient care, thus increasing the risk of using acute care services repeatedly. Variability in the effectiveness of clinical care likely contributes to differences in acute care use. Patients with HF do better when aware of their disease process and self-management strategies (23,24). Perhaps a less consistent and effective effort is made when engaging race/ethnic minority patients to ensure understanding of the care plan upon discharge or outpatient follow-up. Understanding how regional SES might be influencing strains on care networks and increased use of costly acute care services requires further investigation.

Adequate control of hypertension and volume status are critical to clinical management of HFpEF. Additional therapies have not shown effectiveness in altering the natural disease course or improving survival for patients with HFpEF (10). Despite limited treatment strategies, a combination of known behavioral and conventional cardiovascular risk factors predispose to the risk of developing and exacerbating symptoms of HFpEF (25). Recent research highlights the potential to reduce cardiovascular health care use with improvements in lifestyle related cardiovascular risk factors (26). For race/ethnic minorities and black patients especially, targeting known risk factors such as hypertension, diabetes, and obesity may be critical to both preventing and managing HFpEF (27,28).

STUDY LIMITATIONS. This analysis used Medicare Part A administrative data to calculate costs. Costs for Medicare Part B used data related to outpatient visits, inpatient physician payments, and testing, and ambulance services were not included. Medicare Part D was also not included to capture costs related to outpatient prescription drug services. If patients switched to Medicare Advantage plans during the period observation, these costs were not captured for the year following index admission. Overall, these limitations underestimate the true total Medicare expenditures on patients with HFpEF. Prior research using Medical Expenditure Panel Survey data has shown that approximately 40% of the total direct health care expenditures on patients with HF relates to outpatient care, prescription medications, and other services (29). Medicare Part A payments were left as unadjusted costs. The Medicare payment calculator includes adjustments based on geographic factors related to regional differences in facility/provider input costs. Although the generalized linear models used for cost ratios included adjustments for regional SES, these do not mirror adjustments made by the Medicare payment formula. If minority patients are predominately seen in urban hospitals with higher average Medicare payments, there are expected to be residual differences in spending related to Medicare's geographic payment adjustments. The SES factors used decreased the measured disparity in Medicare expenditures. Additional unobserved SES factors not included in the statistical models may further explain differences based on race/ethnicity. There are also potential selection biases because the GWTG-HF registry is based on voluntary hospital participation. However, prior studies have suggested that Medicare beneficiaries enrolled in this registry are representative of the U.S. Medicare population (30).

CONCLUSIONS

Medicare costs for race/ethnic minority patients with HFpEF are greater at index admission and at 1 year after an index admission, suggesting these patients are more vulnerable to use of acute care services. Interventions to prevent readmissions and lower the incidence of HFpEF among all beneficiaries, but especially minority patients, are needed to reduce health care spending on acute care services. A significant portion of the disparity in use relates to differences at the hospital level and regional SES. Further research that investigates the differences in hospital performance in lower SES regions and outpatient care networks are needed to understand differences in the use rate of acute care services.

ADDRESS FOR CORRESPONDENCE: Dr. Gregg C. Fonarow, Ahmanson-UCLA Cardiomyopathy Center, Ronald Reagan UCLA Medical Center, 10833 LeConte Avenue, Room A2-237 CHS, Los Angeles, California 90095-1679. E-mail: gfonarow@mednet.ucla.edu.

PERSPECTIVES

COMPETENCY IN MEDICAL KNOWLEDGE: Vulnerable minority patients with HFpEF are at greater risk for repeat admission after an index hospitalization. Hospital and regional factors increase the risk of acute care service use. Ensuring safe transitions of care out of the hospital and quality outpatient management are important for minimizing the risk of acute hospitalizations and improving patient outcomes.

TRANSLATIONAL OUTLOOK: Further qualitative work evaluating the delivery of hospital and community care is needed to develop interventions that reduce the hospitalization burden for patients with HFpEF, particularly for minority populations.

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KEY WORDS BMI, CMS, diastolic heart failure, health care costs, health care disparities, heart failure with preserved ejection fraction, hospital readmissions, hospitalization

APPENDIX For supplemental tables, please see the online version of this paper.