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ORIGINAL RESEARCH

Geographic Variation in the Quality of Heart Failure Care Among U.S. Veterans

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ABSTRACT

BACKGROUND The burden of heart failure is growing. Guideline-directed medical therapies (GDMT) reduce adverse outcomes in heart failure with reduced ejection fraction (HFrEF). Whether there is geographic variation in HFrEF quality of care is not well described.

OBJECTIVES This study evaluated variation nationally for prescription of GDMT within the Veterans Health Administration.

METHODS A cohort of Veterans with HFrEF had their address linked to hospital referral regions (HRRs). GDMT prescription was defined using pharmacy data between July 1, 2020, and July 1, 2021. Within HRRs, we calculated the percentage of Veterans prescribed GDMT and a composite GDMT *z*-score. National choropleth maps were created to evaluate prescription variation. Associations between GDMT performance and demographic characteristics were evaluated using linear regression.

RESULTS Maps demonstrated significant variation in the HRR composite score and GDMT prescriptions. Within HRRs, the prescription of beta-blockers to Veterans was highest with a median of 80% (IQR: 77.3%-82.2%) followed by angiotensin-converting enzyme inhibitor/angiotensin receptor blocker/angiotensin receptor-neprilysin inhibitors (69.3%; IQR: 66.4%-72.1%), sodium-glucose cotransporter 2 inhibitors (10.3%; IQR: 7.7%-12.8%), mineralocorticoid receptor antagonists (29.2%; IQR: 25.8%-33.9%), and angiotensin receptor-neprilysin inhibitors (12.2%; IQR: 8.6%-15.3%). HRR composite GDMT *z*-scores were inversely associated with the HRR median Gini coefficient ($R = -0.13$; $P = 0.0218$) and the percentage of low-income residents ($R = -0.117$; $P = 0.0413$).

CONCLUSIONS Wide geographic differences exist for HFrEF care. Targeted strategies may be required to increase GDMT prescription for Veterans in lower-performing regions, including those affected by income inequality and poverty. (J Am Coll Cardiol HF 2023;■:■-■) © 2023 the American College of Cardiology Foundation. Published by Elsevier. All rights reserved.

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ABBREVIATIONS AND ACRONYMS

ACEI = angiotensin-converting enzyme inhibitor

ARB = angiotensin receptor blocker

ARNI = angiotensin receptor-neprilysin inhibitor

eGFR = estimated glomerular filtration rate

GDMT = guideline-directed medical therapy

HF = heart failure

HFrEF = heart failure with reduced ejection fraction

HRR = hospital referral region

LVEF = left ventricular ejection fraction

MRA = mineralocorticoid receptor antagonist

SGLT2i = sodium-glucose cotransporter 2 inhibitor

VA = Veterans Health Administration

Heart failure (HF) is estimated to affect over 6 million Americans, and mortality is increasing.[1,2] Despite the mortality benefit of guideline-directed medical therapies (GDMT) in heart failure with reduced ejection fraction (HFrEF), gaps in care persist; the prescription of GDMT is suboptimal and has increased only marginally in the last several years.[3,4] Significant disparities exist in HF care. The U.S. Midwest and South have higher rates of HF mortality and the greatest age-standardized HF prevalence.[2,5] Prior work has evaluated the national rates of GDMT receipt in the Veterans Health Administration (VA) and the prescription of angiotensin receptor-neprilysin inhibitors (ARNIs).[4,6] Further evaluation of geographic differences in HFrEF quality of care may better direct resources and identify factors that contribute to gaps in care.

We studied regional variation in GDMT prescribing for HFrEF across the VA nationally. As the largest integrated U.S. health system, the VA affords the opportunity to study cardiovascular care nationwide and observe regional variations. We evaluated differences in the prescription of beta-blockers, mineralocorticoid receptor antagonists (MRAs), sodium-glucose cotransporter 2 inhibitors (SGLT2is), angiotensin-converting enzyme inhibitor/angiotensin receptor blocker (ARB)/ARNIs, and ARNI alone within hospital referral regions (HRRs). HRRs are formed by aggregating hospital service areas (HSAs). As defined by the Dartmouth Atlas, HSAs are formed by assigning zip codes to groups that share where the majority of their Medicare beneficiaries are hospitalized, and HSAs mimic local health care markets. Then, HSAs are combined into HRRs based on where the majority of their patients' major cardiovascular procedures are performed. Although HRRs do not necessarily correspond to VA-specific referral patterns, they align with regional markets for medical care and therefore provide the opportunity to analyze care for Veterans based on differences in geography.[7] Ascertaining regional patterns in GDMT prescribing may uncover systematic issues that limit HFrEF care quality and prove useful for reducing regional differences for Veterans.

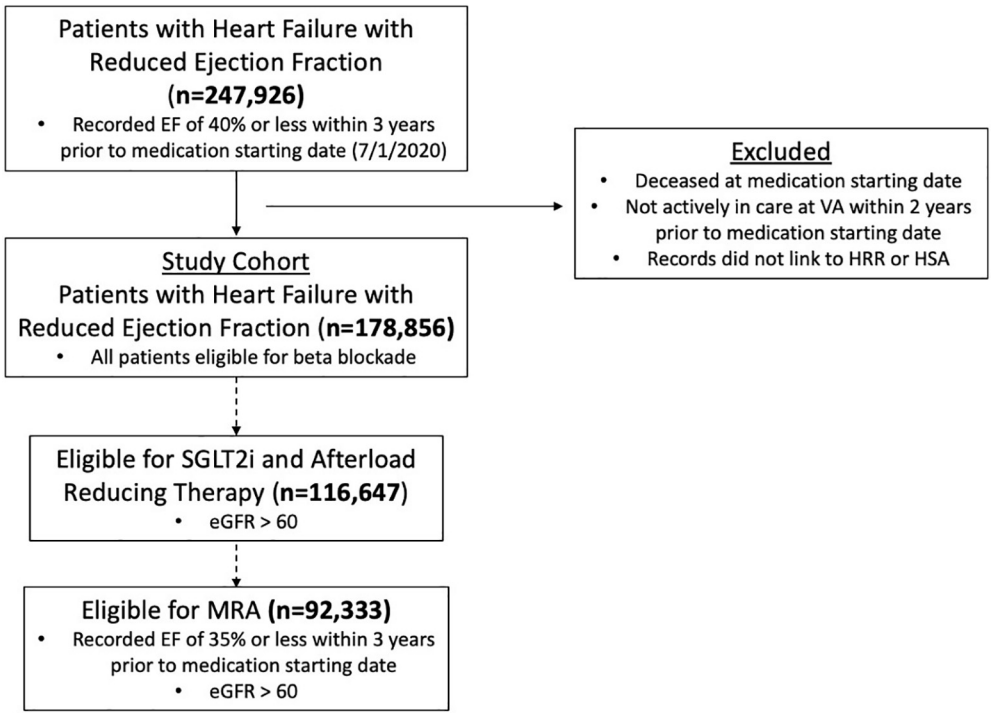
METHODS

STUDY POPULATION. We identified Veterans with HFrEF from July 1, 2017, to July 1, 2020, with any measurement of left ventricular ejection fraction (LVEF) ≤40% and a diagnosis of heart failure who were active in the VA health care system between July 1, 2018, and July 1, 2020, using International Classification of Diseases-Ninth or Tenth Revision codes (Supplemental Table 1) with a single code required for cohort eligibility.[8] LVEF was defined from echocardiography notes, which had been filtered from the medical record using a natural language processing algorithm. In prior validation, this algorithm had an accuracy of 100% in classifying 339 echocardiograms regarding whether ejection fraction was greater than 40% or not.[9] Active Veterans were connected to VA-based health care or interacted with the VA health care system. Veterans were defined as active if they were assigned to a primary care team, filled a prescription, had an outpatient visit or admission, or had an upcoming appointment scheduled during this time; accordingly, for patients who had multiple encounters with the VA, each of these encounters was considered an opportunity for GDMT prescription. Participants who were deceased before July 1, 2020, were excluded.

GEOCODING. Patients were linked by the zip code of their primary residence to the HRR.[7] There are 306 HRRs nationally. This linkage allowed us to study variations in GDMT prescription based on differences in the location of Veterans' primary residence (Supplemental Figures 1 and 2). Observations without HRR linkages or that belonged to HRRs with 10 or fewer Veterans were excluded.

VARIABLE DEFINITION. At least 1 active prescription between July 1, 2020, and July 1, 2021, was considered a success for each GDMT class. Active prescriptions were determined by VA clinician orders through the VA pharmacy system. Non-VA medication orders are based on clinician entry of start and stop dates of prescriptions not dispensed by the VA that patients were taking. Both VA and non-VA data were used to identify active GDMT prescriptions. All patients meeting inclusion criteria were eligible for beta-blockade. Eligibility for ACEIs/ARBs/ARNIs and SGLT2is was defined as having an estimated glomerular filtration rate (eGFR) >60 mL/min/1.73 m^2. Eligibility for MRA was defined as having an eGFR >60 mL/min/1.73 m^2 and ejection fraction ≤35%. Definitions were consistent with the American College of Cardiology/American Heart Association Performance Measure Guideline.[10] Within each HRR, the percentage of eligible patients who were prescribed a class of GDMT was calculated. To determine which HRRs had the highest prescriptions, a *z*-score was constructed for each region's performance

FIGURE 1 Study Cohort



This flowchart depicts how our cohort of 178,856 Veterans was selected. We also delineate subgroups that were eligible for sodium-glucose cotransporter 2 inhibitor (SGLT2i) and afterload-reducing therapy (n = 116,647), mineralocorticoid receptor antagonist (n = 92,333), and exclusion criteria. Afterload reducing therapy is angiotensin-converting enzyme inhibitor/angiotensin receptor blocker/angiotensin receptor–neprilysin inhibitor. EF = ejection fraction; eGFR = estimated glomerular filtration rate; HRR = hospital referral region; HSA = hospital service area; VA = Veterans Health Administration.

measure. As a composite measure, we summed the *z*-score for the 4 GDMT classes for each HRR.

STATISTICAL ANALYSIS. Cohort summary statistics were obtained for sex, race, age, and comorbid conditions from the VA Corporate Data Warehouse. A chi-square test of independence was used to determine if there was a relationship between sex and prescription rates. We used scatterplots to evaluate the relationship between GDMT regional performance and the median Gini coefficients for the zip codes in HRRs, the percentage of low-income patients (defined as having an income of 200% of the federal poverty level or less, with sensitivity analyses performed at thresholds of 100% and 50% of the federal poverty level or less), the percentage of Black patients, and the percentage of Hispanic or Latino patients using U.S. Census Bureau data.[11-13] The Gini coefficient is a measure of income inequality based on differences between a theoretical income distribution with equality and a region's true income distribution, with values ranging from 0 (complete equality) to 1 (complete inequality).[14] A linear regression was performed for each scatterplot. The level of significance for hypothesis testing was $P < 0.05$.

DATA VISUALIZATION. To represent variation in GDMT prescriptions, we constructed choropleth maps using R package ggplot2 (R Foundation for Statistical Computing).[15] The map for our primary outcome represented variation in the composite prescription score across HRRs. Separate maps were constructed to denote differences in prescribing for each GDMT class and ARNI. We first created a map with HRR boundaries by using a publicly available geographic boundary file.[15] Next, numerical metrics such as medication prescription percentages and composite *z*-scores were merged with the geospatial data. Finally, choropleth maps were generated after the selection of color palettes, legend representations, and scale transformations. The zip codes of VA facilities with cardiology encounters were used to determine geographic locations of cardiology clinics

TABLE 1 Veterans Health Administration Heart Failure With Reduced Ejection Fraction Cohort Characteristics

Total	178,856 (100)
Sex	
Male	174,178 (97.4)
Female	4,678 (2.6)
Race	
White	128,596 (71.9)
Black	36,283 (20.3)
Native Hawaiian or other Pacific Islander	1,618 (0.9)
American Indian or Alaskan Native	1,399 (0.8)
Asian	925 (0.5)
Age, y	72.7 ± 10
Most recent EF, %[a]	40 (30-52.5)
Patients with most recent EF ≤40%	102,212 (57.1)
Most recent eGFR, mL/min/1.73 m^2	58 (44-75.8)
Comorbidity	
Hypertension	171,468 (95.9)
Coronary artery disease	140,086 (78.3)
Diabetes	106,137 (59.3)
Chronic obstructive pulmonary disease	95,793 (53.6)
Atrial fibrillation	88,800 (49.6)
Depression	86,436 (48.3)
Sleep apnea	82,806 (46.3)
Chronic kidney disease	76,214 (42.6)
PTSD	42,574 (23.8)
Acute coronary syndromes	19,862 (11.1)
Dementia	16,126 (9.0)
Cognitive impairment	14,566 (8.1)

Values are n (%), n (%), mean ± SD, or median (IQR). [a]All patients had a qualifying left ventricular ejection fraction ≤40% between July 1, 2017, and July 1, 2020.

EF = ejection fraction; eGFR = estimated glomerular filtration rate; PTSD = posttraumatic stress disorder.

and telehealth visits within HRRs, with clinics documenting fewer than 5 encounters excluded to account for miscoding.[16] Analyses were performed with SAS Version 9.4 (SAS Institute Inc), R version 4.0.4 (R Foundation for Statistical Computing) and Microsoft Excel.[17,18] OpenStreetMap (OpenStreetMap Foundation) and Mapbox supported Tableau (Salesforce, Inc) map creation for cardiology clinic locations and telehealth visits. OpenStreetMap is a trademark of the OpenStreetMap Foundation, and is used with their permission. This project is not endorsed by or affiliated with the OpenStreetMap Foundation.[19-21] Authors B.Z. and X.W. had access to all data and analyses.

RESEARCH APPROVAL AND GROUP. Institutional Review Board approval was obtained from the VA Greater Los Angeles Healthcare System.

RESULTS

PATIENT COHORT. There were 178,856 Veterans in the cohort, 116,647 of whom had an eGFR >60 mL/min/1.73 m^2 and were eligible for SGLT2is and ACEs/ARBs/ARNIs and 92,333 also had an LVEF ≤35% and were eligible for MRA (Figure 1). The cohort was 97.4% male and 71.9% White with an average age of 72.7 years. The rate of comorbid coronary artery disease was 78.3%, and for diabetes, it was 59.3% (Table 1). Nationwide prescription rates for eligible patients were 79.4% for beta-blockers, 29.9% for MRAs, 11.3% for SGLT2is, 68.9% for any afterload-reducing medication, and 11.9% for ARNIs (Table 2). For all medication classes except MRAs, a greater percentage of men were prescribed compared to women ($P < 0.05$ for all except MRAs). For instance, 80% of men were prescribed beta-blockers compared to 72% of women (Table 2). For all medication classes, there were differences in prescribing percentages based on race ($P < 0.001$). A greater percentage of Black patients compared with White patients were prescribed each medication class except for beta-blockers (Table 2).

CHOROPLETH MAPS OF GDMT PRESCRIPTION. The HRRs with the highest composite scores of GDMT prescribing were not concentrated in any region (Figure 2A). Several HRRs in Texas, the Northeast (such as New York State, Massachusetts, New Hampshire, and Maine), Great Plains (including Oklahoma, Kansas, and Nebraska), and mid-Atlantic (such as Virginia, Maryland, and North Carolina) region had higher composite scores, and many of the lower-prescribing areas were in the Southern and Western United States (Figure 2A). Texas, the Midwest, Northeast, and Southern United States had some of the HRRs with both the highest and lowest ACEI/ARB/ARNI prescribing (Figure 2B). ARNI prescription was low overall, but the Southeast (such as Georgia, Florida, and South Carolina) and Texas had comparatively higher prescribing (Figure 2C). Beta-blockade prescription was high overall, but a few regions in Texas, Indiana, and the Southern and Western United States had lower prescription (Figure 2D). MRA prescriptions were low, but 1 area in North Texas and another in Central Texas had high prescription rates (Figure 2E). The SGLT2i prescription rate was low, but, relatively, Texas, the mid-Atlantic, Great Plains, and Washington State and Alaska had higher prescription rates (Figure 2F). Maps denoting raw prescribing percentages for each class across HRRs are depicted in Figure 3. Maps depicting prescribing for each class across HSAs are depicted in Supplemental Figures 5 to 14.

VARIATIONS IN COMPOSITE CLASS MEDICATION PRESCRIPTION BY HRR. The HRRs with the highest composite prescription scores were Pontiac, MI;

TABLE 2 Nationwide GDMT Class Prescribing and Differences by Sex and Race

	ACEI/ARB/ARNI (n = 116,647)	ARNI (n = 116,647)	Beta-Blockers (n = 178,856)	MRA (n = 92,333)	SGLT2i (n = 116,647)
Prescription, %	68.9	11.9	79.4	29.9	11.3
Male prescription, %	78,559 (69.2)	13,633 (12.0)	138,638 (80.0)	26,905 (29.9)	12,912 (11.4)
Female prescription (%)	1,854 (60.4)	293 (9.5)	3,359 (71.8)	705 (30.5)	258 (8.4)
P value	<0.001	<0.001	<0.001	0.55	<0.001
Race					
White prescription (%)	57,056 (68.3)	9,258 (11.0)	102,384 (79.6)	18,312 (28.1)	9,144 (10.9)
Black prescription (%)	17,178 (71.2)	3,603 (14.9)	28,773 (79.3)	7,136 (36.1)	3,007 (12.5)
Other prescription (%)	6,179 (68.9)	1,065 (11.9)	10,840 (77.6)	2,162 (29.7)	1,019 (11.4)
P value	<0.001	<0.001	<0.001	<0.001	<0.001

Values are % or n (%) unless otherwise indicated.

ACEI = angiotensin-converting enzyme inhibitor; ARB = angiotensin receptor blocker; ARNI = angiotensin receptor-neprilysin inhibitor; MRA = mineralocorticoid receptor antagonist; SGLT2i = sodium-glucose cotransporter 2 inhibitor.

Victoria, TX; Albany, GA; Ridgewood, NJ; and Wichita Falls, TX (Table 3). Within each HRR, a median of 80.0% (IQR: 77.3%-82.2%) of eligible patients were prescribed beta-blockers (Table 3). For afterload reduction, a median of 69.3% (IQR: 66.4%-72.1%) of eligible patients were prescribed (Table 3). SGLT2is (median: 10.3%; IQR: 7.7%-12.8%), MRAs (29.2%; IQR: 25.8%-33.9%), and ARNIs (median: 12.2%; IQR: 8.6%-15.3%) were significantly less prescribed (Table 3). These median rates for each medication were similar to nationwide prescription rates (Table 2).

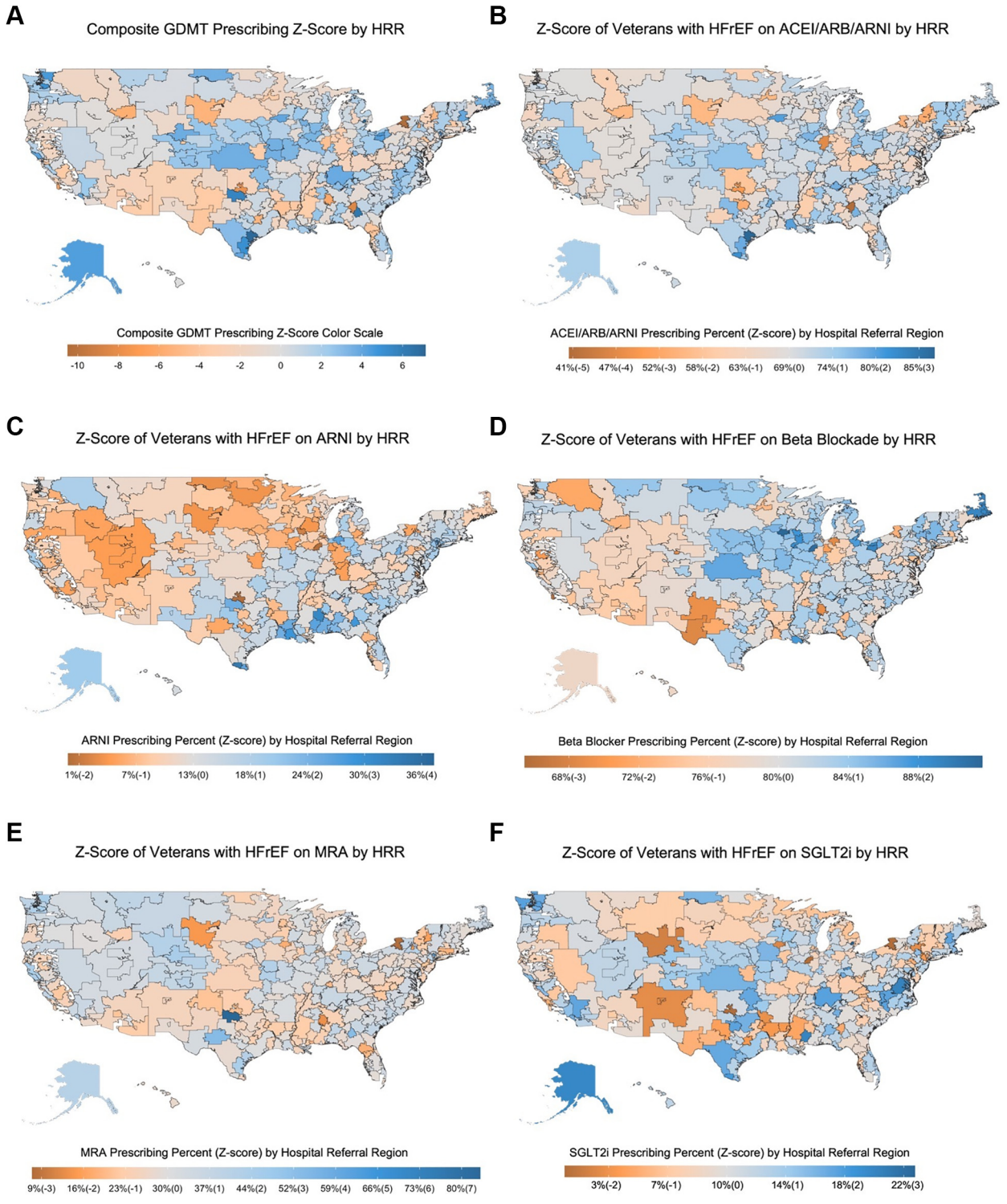
DEMOGRAPHIC AND SOCIOECONOMIC ANALYSIS OF VARIATIONS IN MEDICATION PRESCRIBING. There was a modest inverse relationship between the median Gini coefficient for the zip codes in an HRR and the HRR composite GDMT score ($R = -0.13$; $P = 0.0218$ with linear regression) (Figure 4A). There was no linear relationship between the percentage of the members of an HRR who were African American and the composite score ($R = -0.027$; $P = 0.633$) (Supplemental Figure 3A) or Hispanic or Latino and the composite score ($R = -0.0071$; $P = 0.901$) (Supplemental Figure 3B). There was a modest inverse relationship between the percentage of the members of an HRR who were low income and the composite score regardless of the threshold for low income (Figures 4B to 4D) ($P < 0.05$ for all). When performing a sensitivity analysis using Spearman's correlation, these inverse relationships between median Gini coefficients and HRR composite GDMT scores and the percentage of low-income residents and the composite score persisted (Figures 4A to 4D) ($P < 0.05$ for all). We also found that cardiology clinic access and telehealth use were associated with GDMT prescription. Of the HRRs that were in the top 10% with respect to cardiology visits, 60% were above the median in composite prescription. Conversely, 7 of the 10 HRRs with the lowest composite prescription scores did not have a VA cardiology clinic. Of the HRRs in the top 5% with respect to VA cardiology telehealth visits, 67% were above the median in composite GDMT prescribing. Of the HRRs in the top 10% in VA cardiology telehealth visits, 57% were above the median in composite prescribing. By contrast, 8 of the 10 HRRs with the lowest composite prescription rates did not have any VA cardiology telehealth visits. Supplemental Figure 4 depicts VA cardiology clinic locations and locations of cardiology telehealth visits by zip code.

DISCUSSION

We have identified geographic differences in the prescribing of GDMT for Veterans (Central Illustration). Within broad geographic areas, there was high variation; for instance, although the Northeast had several HRRs with the highest prescribing rates, some areas with lower prescribing rates were in New York. These findings demonstrate that more granular geographic analysis at the HRR level may be helpful to direct resources toward regions with lower prescription rates.

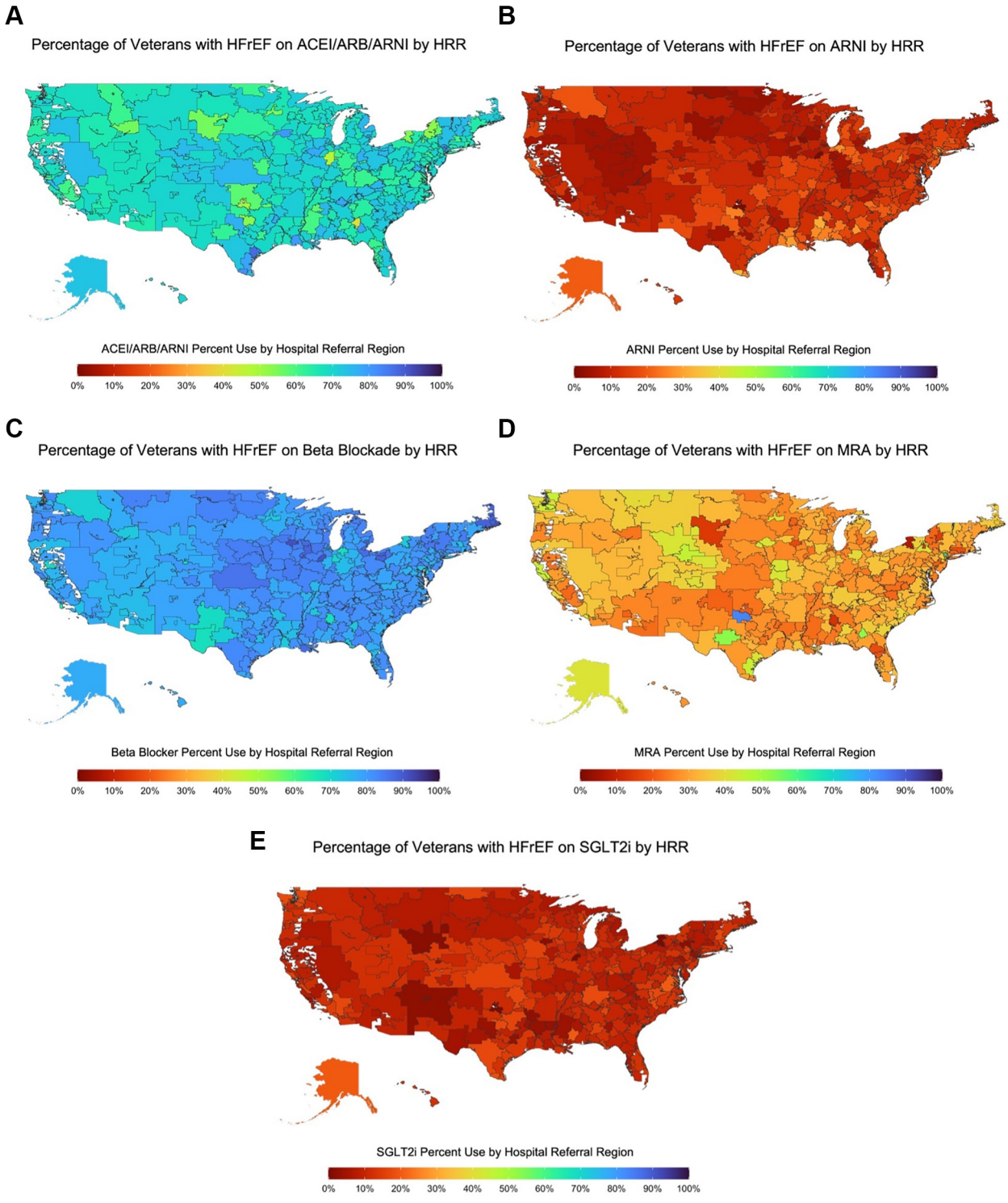
COST AND OTHER POTENTIAL BARRIERS TO GDMT. Cost has been hypothesized to contribute to low GDMT prescription rates. These financial barriers are generally less present in the VA. Veterans with higher service connection generally do not pay copayments, and those without service connection pay no more than $11 per month for branded medications with a $700 annual cap for all medications.[22] In 2017, the VA defined criteria that restricted the use of ARNIs.[23] For SGLT2is, empagliflozin prescription for HFrEF required patients to have LVEF <40%, NYHA functional class II to III symptoms, and receipt of

FIGURE 2 Relative Geographic Variation in the Use of GDMT



These choropleth maps demonstrate significant geographic variation in **(A)** composite guideline-directed medical therapy (GDMT) *z*-score by HRR and **(B to F)** *z*-scores of individual GDMT classes. Regions with orange had a *z*-score that was less than the median, with median *z*-scores denoted by white. Regions with blue had a *z*-score that was greater than the median. ACEI = angiotensin-converting enzyme inhibitor; ARB = angiotensin receptor blocker; ARNI = angiotensin receptor–neprilysin inhibitor; HFrEF = heart failure with reduced ejection fraction; MRA = mineralocorticoid receptor antagonist; other abbreviations as in Figure 1.

FIGURE 3 **Absolute Geographic Variation in the Use of GDMT**



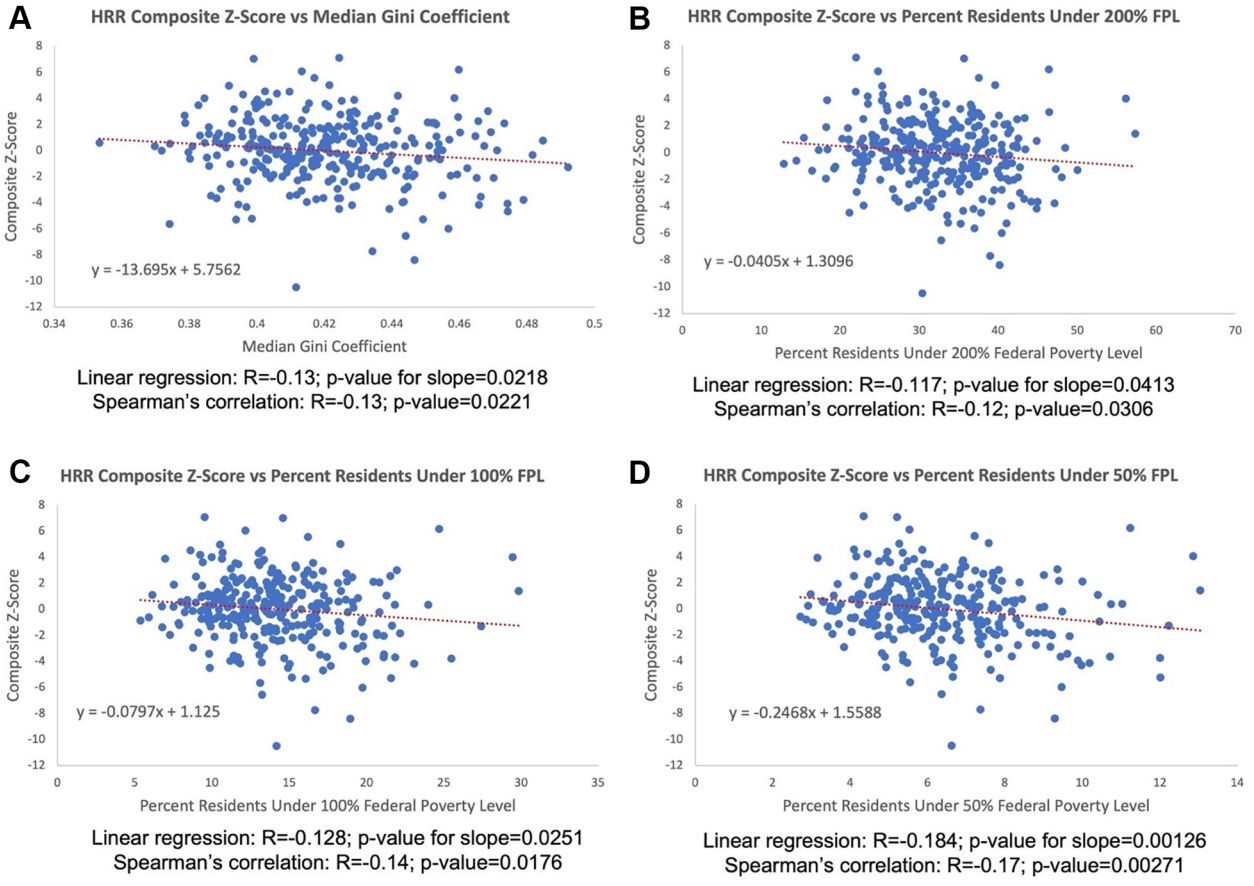
These choropleth maps show significant variation in the percentage of Veterans by HRR who were prescribed individual GDMT classes. Overall, beta-blockers were the highest prescribed medication, with significantly less prescribing of SGLT2i, ARNI, and MRA. Abbreviations as in Figures 1 and 2.

TABLE 3 Geographic Distribution of Guideline-Directed Medical Therapy Class Prescription by HRR and Highest-Prescribing HRRs

Patients prescribed per HRR, %	ACEI/ARB/ARNI 69.3 (66.4-72.1)	ARNI 12.2 (8.6-15.3)	Beta-blockers 80.0 (77.3-82.2)	MRA 29.2 (25.8-33.9)	SGLT2i 10.3 (7.7-12.8)
Range of patients prescribed, %	40.9-87.2	0-36.8	65-91.3	7.1-83.3	0-22.5
Highest-prescribing HRRs (#1 to #5)	Victoria, TX	Ridgewood, NJ	Waterloo, IA	Wichita Falls, TX	Pontiac, MI
	Ridgewood, NJ	McAllen, TX	Bloomington, IL	Ridgewood, NJ	Provo, UT
	Pontiac, MI	Meridian, MS	Canton, OH	San Angelo, TX	Richmond, VA
	McAllen, TX	Lafayette, LA	Bangor, ME	Albany, GA	Hattiesburg, MS
	Mason City, IA	Albany, GA	Akron, OH	Tacoma, WA	Anchorage, AK
Composite highest-prescribing HRRs (#1 to #5)	Pontiac, MI				
	Victoria, TX				
	Albany, GA				
	Ridgewood, NJ				
	Wichita Falls, TX				

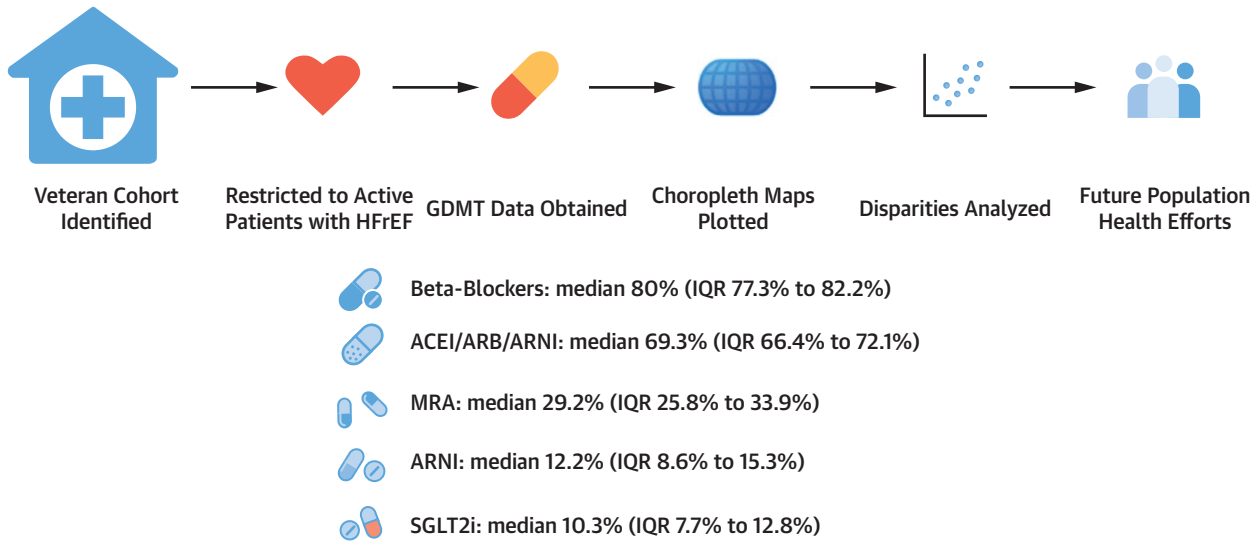
Values are median (IQR) or minimum to maximum.
HRR = hospital referral region; other abbreviations as in Table 2.

FIGURE 4 Associations Between HRR GDMT Prescribing and Demographic Characteristics



These graphs depict a significant inverse relationship between **(A)** HRR GDMT composite *z*-score and median HRR Gini coefficient as well as **(B to D)** the percentage of low-income residents ($P < 0.05$ for all). FPL = federal poverty level; HRR = hospital referral region.

CENTRAL ILLUSTRATION **Veteran Heart Failure Quality of Care Study Design and Guideline-Direct Medical Therapy Prescribing**



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This cartoon shows how we analyzed differences in heart failure with reduced ejection fraction (HFrEF) quality of care for Veterans by geography. All icons in this Central Illustration were derived from Icons8.[43] ACEI = angiotensin-converting enzyme inhibitor; ARB = angiotensin receptor blocker; ARNI = angiotensin receptor-neprilysin inhibitor; GDMT = guideline-directed medical therapy; MRA = mineralocorticoid receptor antagonist; SGLT2i = sodium-glucose cotransporter 2 inhibitor.

other GDMT medications as tolerated. Also, prescription of high-cost GDMT medications may be restricted to cardiologists in some settings. Therefore, barriers to specialist access and use criteria may contribute to low prescription rates. Our linear regressions suggest social determinants of health and local economic factors contribute to gaps in higher-quality HF care even within the VA but that other noneconomic factors may contribute as well. For instance, 4 of the 5 lowest-prescribing regions were in the top 30% when HRRs were ranked by the Gini coefficient. Albany, GA, was a notable outlier; it was in the top 10% of HRRs for the Gini coefficient but was one of the highest-performing HRRs. In future work, it would be helpful to determine how Albany, GA, was able to achieve higher prescribing rates despite the challenges of local economic factors. Moreover, the system-wide nature of the VA affords cardiology division leadership in VA facilities based in different HRRs the opportunity to discuss and share opportunities for improvement.

In addition to economic factors, our study also revealed sex-based differences in prescribing. Further study is needed to determine whether preventable factors impact differences in GDMT prescribing between men and women and whether these sex-based differences persist after adjustment for other factors such as geography.

Much work remains to identify the reasons underlying nonprescription of GDMT.[24] Outpatient care for many HF patients still largely occurs in primary care.[25,26] Primary care providers may be less likely to prescribe GDMT compared with cardiologists, and our work suggests that access to a cardiology clinic may be beneficial in promoting GDMT prescription and that absence of a cardiology clinic may be a contributor to lower prescription rates in lower-performing HRRs.[27,28] The need for close follow-up, management of side effects, and frequent lab draws may limit prescription of GDMT as well as provider inertia.[29,30] Inexperience with initiating therapy may limit prescription as well. Therefore, education regarding appropriate prescription and uptitration may help increase prescription rates.[31,32] Accordingly, the incorporation of a pharmacist in care may help increase prescribing of GDMT while minimizing intolerable side effects.[33,34] We found that telehealth may be associated with increased prescription of GDMT, and further work remains to ensure that telehealth is used equitably in care; patients who are older, prefer

a language other than English, or are on Medicaid are less likely to complete a telehealth visit, and there are racial disparities in Internet use.[35,36] Additionally, patients from rural areas are less likely to have video-based telehealth visits.[37] If telehealth is used in HFrEF care, it is crucial that it expands access rather than perpetuating disparities. For patients with transportation difficulties, for instance, after-hours visits, rideshare programs and telehealth may be beneficial in increasing GDMT prescription.

Given the unified nature of the VA, system-level interventions such as greater cardiology clinic access or telehealth offerings can potentially be used to increase GDMT prescribing, and these are interventions that may be effective in non-VA systems as well. As explored by our colleagues at VA, the care of a multidisciplinary team including a pharmacist and nurse in addition to remote monitoring of heart failure patients increases prescribing, and these are interventions that can potentially be applied at the clinic level.[38] Another systems-level practice is protocol-driven rapid titration of GDMT and close follow-up postdischarge for HF exacerbation, which was recently shown in STRONG-HF (Safety, Tolerability, and Efficacy of Up-Titration of Guideline-Directed Medical Therapies for Acute Heart Failure) to reduce rates of HF hospitalization and all-cause mortality.[39]

STUDY LIMITATIONS. For limitations, electronic health care record (EHR) data were used to document prescription of GDMT. EHR documentation may be incomplete for non-VA medications. Generally, Veterans have no or lower financial costs for generic and branded medications when using the VA pharmacy system rather than non-VA sources. Among dual-health system users, Veterans often use VA pharmacy benefits given the cost advantage. One study estimated that dual-use Veterans obtained 17.4% of their medications outside the VA.[40] Another study estimated that over 50% of patients who receive medications outside the VA share this information with VA clinicians either never or infrequently. Therefore, our ability to accurately assess GDMT prescription outside the VA is incomplete.[41] Furthermore, assessment of GDMT prescribing is likely an overestimation of use because some Veterans may not have received prescriptions. We based contraindications to ACEs/ARBs/ARNIs and MRAs based on renal function estimated from laboratory data. Prior intolerances or other adverse reactions relevant for exclusion are typically not captured by EHR systems and were not accounted for in this study. Also, it is possible that some Veterans had a more recent echocardiogram outside the VA that was not captured by the natural language processing algorithm. Among a propensity-matched cohort of Veterans who used Medicare compared to VA beneficiaries, the use of transthoracic echocardiography was shown to be almost 3-fold higher, suggesting that dual-use Veterans may be obtaining echocardiograms more frequently than their counterparts who are solely receiving VA care.[42] Lastly, the VA is the world's largest integrated health care system, and practice patterns may not reflect other U.S. health care systems with respect to patient population, prescription medication access, and use of services.

CONCLUSIONS

Although specific HRRs had high rates of prescribing of 1 or more GDMT classes, there were wide differences in prescription across HRRs. Prescription rates of MRAs, SGLT2is, and ARNIs to eligible Veterans are low nationwide. Lastly, there was an association between socioeconomic factors and lower rates of GDMT. Additional studies evaluating contributing factors to these geographic differences may help improve prescription and clinical outcomes for Veterans with HFrEF in lower-prescribing regions. Improved access to specialty cardiology care and better use of telecardiology services may help alleviate regionally related differences in care quality.

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PERSPECTIVES

COMPETENCY IN SYSTEMS-BASED PRACTICE: We identify significant differences in the prescription of GDMT to veterans residing in geographic areas corresponding to different HRRs and denote high- and low-prescribing regions. Within broader geographic divisions, such as U.S. Census regions, there was significant prescribing heterogeneity because many areas contained both some of the highest- and lower-prescribing HRRs. GDMT prescription was high for beta-blockade and afterload reduction but low for other classes.

TRANSLATIONAL OUTLOOK: Future granular geographic analysis may be beneficial to identify and correct differences in HFrEF care. Specifically, it is important to further study why prescription of ARNIs, MRAs, and SGLT2is to veterans is low and to apply factors that promote prescription of GDMT in lower-prescribing HRRs. Emerging strategies including incorporation of pharmacists in prescribing, physician education, and focused expansion of access in areas with a greater prevalence of poverty, income inequality, and transportation difficulty through approaches such as telehealth may ameliorate differences in GDMT prescription.

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