Journal of the American Heart Association

ORIGINAL RESEARCH

Relationship Between Health Care Team Segregation and Receipt of Care by a Cardiologist According to Patient Race in a Midwestern State

Janina Quintero Bisonó, MD, MS; Shannon M. Knapp, PhD; Dalancee Trabue, MS; Ryan Yee, MS; Francesca Williamson, PhD; Adedoyin Johnson, MD, PhD; Stephen Watty, MD; Natalie Pool, PhD, RN; Megan Hebdon, PhD; Wanda Moore, CCHE; Ekow Yankah, JD; Nneamaka Ezema, PM, CCRA, MBA; Nia Kimbrough, BS; Karen Lightbourne, MBA; Brownsyne Tucker Edmonds, MD, MPH, MS; Quinn Capers, MD; David Brown, MD; Denee Johnson, LPN; Jalynn Evans, MHA; Brandi Foree, NP; Anastasia Holman, M. Div., MBA, BCC; Courtland Blount, MD; Brahmajee Nallamothu, MD, MPH; John M. Hollingsworth, MD, MS; Khadijah Breathett, MD, MS

BACKGROUND: Segregation index (SI) has been associated with worsened health. However, the relationship between SI within health care teams (degree of heterogeneity between teams caring for Black compared with White patients) and cardiovascular care is unclear among adequately insured populations. We sought to assess the relationship between health care team SI, patient race, receipt of care by a cardiologist, 1-year survival, and 30-day readmission rates for Black compared with White patients admitted with heart failure, ischemic heart disease, or valvular heart disease.

METHODS: Using Optum's de-identified Clinformatics Data Mart Database (CDM) from 2009 to 2020, generalized linear mixed-effects were used to analyze effects of patient race and SI on receipt of care by a cardiologist, and care by a cardiologist on 1-year survival and 30-day readmission.

RESULTS: Among 6572 patients (17.1% Black), the odds of receiving care by a cardiologist were 31.3% less for Black than White patients (adjusted odds ratio 0.687 [95% CI, 0.545–0.872]; P=0.001). However, there was no statistically significant association of SI on receipt of care by a cardiologist (P=0.14). For those seen by a cardiologist, the adjusted odds ratio (Black-to-White) of 1-year survival increased with increasing SI (P=0.02). SI had no statistically significant effect on 30-day readmission (P=0.86).

CONCLUSIONS: Among patients hospitalized for heart failure, ischemic heart disease, or valvular heart disease, segregation of health care teams was not associated with receipt of care by cardiologists in Indiana hospitals. When cardiologists were included, the odds of 1-year survival increased for Black versus White patients with increasing segregation of clinicians, and segregation was not associated with 30-day readmission.

Key Words: cardiovascular diseases ■ health equity ■ quality of care ■ racial disparities ■ readmission ■ segregation index ■ survival

Correspondence to: Khadijah Breathett, MD, MS, Division of Cardiovascular Medicine, Indiana University, 1800 North Capitol Ave, Indianapolis, IN 46202. Email: kbreath@iu.edu

This manuscript was sent to Mahasin S. Mujahid, PhD, MS, FAHA, Associate Editor, for review by expert referees, editorial decision, and final disposition.

Supplemental Material is available at https://www.ahajournals.org/doi/suppl/10.1161/JAHA.124.037197

For Sources of Funding and Disclosures, see page 8.

JAHA is available at: www.ahajournals.org/journal/jaha

CLINICAL PERSPECTIVE

What Is New?

- In this study of 6572 patients, segregation index was not statistically significantly associated with the odds of receiving care by a cardiologist (P=0.14).
- There was a synergistic relationship between care by cardiologist, race, and segregation index on 1-year survival.
- For those seen by a cardiologist, the adjusted odds ratio of 1-year survival for Black relative to White patients increased with increasing segregation (P=0.02); segregation index had no statistically significant effect on 30-day readmission (P=0.86).

What Are the Clinical Implications?

- Complex interactions exist between health care segregation, receipt of care by a cardiologist, 1-year survival, 30-day readmission, and race; further investigation should address how cardiologists are selected for patients' health care teams.

Nonstandard Abbreviations and Acronyms

CDM	Clinformatics Data Mart Database
IHD	ischemic heart disease
SI	segregation index
VHD	valvular heart disease

Non-Hispanic Black patients have the greatest cardiovascular disease (CVD) burden,[1] with the highest mortality post–myocardial infarction, higher readmission rates for heart failure (HF), and the highest overall death rate from CVD.[2–4] Despite numerous studies showing racial disparities for non-Hispanic Black patients with CVD in the United States, significant differences persist in the quality of care delivered. In fact, non-Hispanic Black patients are less likely to be evaluated by a cardiologist when presenting to the emergency room or admitted to the intensive care unit for HF.[5,6] A recent study demonstrated that segregated care teams were associated with racial disparities in survival following coronary artery bypass grafting and posited that reducing clinician care team segregation within a hospital may reduce racial inequalities after coronary artery bypass grafting.[7]

Major challenges to reducing racial inequalities in CVD are related to implicit bias, structural racism, and social determinants of health.[8–11] Financial toxicity, underinsurance, and lack of standardized care in the up-titration of guideline-directed medical therapy also contribute to inequitable care, particularly in Black patients with HF.[12] Attempts to uncover barriers in CVD care have been challenging due to the underrepresentation of non-Hispanic Black relative to non-Hispanic White patients within many medical studies and trials.[2,3,13,14] Furthermore, studies have yet to evaluate the relationship between the health care team, patient race, receipt of care, and their impact on overall CVD outcomes.

Segregation index (SI) has been used to measure the degree of segregation between racial groups within specific geographic areas and is associated with worse health outcomes.[5] Neither the degree of segregation of care in Indiana hospitals for CVD nor the relationship between health care team SI, patient race, and receipt of care for non-Hispanic Black patients is known. It is also unclear how SI and receipt of care are associated with survival between racial groups. We used a national claims database to evaluate the effects of health care team SI and patient race on the receipt of care by a cardiologist and the effects of all 3 factors on patient outcomes, 1-year survival, and 30-day readmission among non-Hispanic Black and non-Hispanic White patients admitted with HF, ischemic heart disease (IHD), or valvular heart disease (VHD) as a primary diagnosis in hospitals in Indiana. This study raises the importance of receipt of care by a cardiologist to achieve equity.

METHODS

Data Source

Our analyses used Optum's de-identified Clinformatics Data Mart Database (CDM), a commercial and Medicare Advantage plan claims database of ≈67 million beneficiaries across all 50 United States. CDM is a closed system of administrative health claims that includes information on patient demographics, including race and ethnicity, medical, pharmacy, and inpatient confinement claims. Optum has licensed these data to Indiana University for use in research projects.[15] Since data are de-identified, this study was exempt from review by the Indiana Institutional Review Board. Requests for de-identified data must go through Optum licensing process for CDM because the authors do not own the data.

Segregation Index

SI was calculated as an absolute value (Clinician Care Team Segregation=0.5 $\sum|b_i - w_i|$), where b_i is the relative frequency of Black patients, and w_i is the relative frequency of White patients for the ith clinician[7]; where the relative frequency is the number of patients of the specified race for the ith clinician, divided by the total number of Black and White patients for the ith clinician. We calculated SI by hospital-year combination, so the

summation is over all clinicians in a hospital year. Zero represents a situation where the ratio between the numbers of Black and White patients treated by a clinician is the same for all clinicians (ie, no clinician care team segregation exists). When the measure equals 1, the clinician care teams are completely segregated such that each clinician in a hospital's care team treats only Black or White patients.[7] This measure is equivalent to the dissimilarity index, substantiated in the health care disparities literature.[16] Clinicians were defined as any individual "provider" in CDM (eg, physicians, nurses, physical therapists, nutritionists, and social workers).

Hospital Population

For the calculation of SI, we first selected all *International Classification of Diseases, Ninth Revision* (*ICD-9*) and *International Classification of Diseases, Tenth Revision* (*ICD-10*) codes corresponding to admissions with a primary diagnosis of HF, IHD, or VHD (Table S1) at Indiana hospitals between January 1, 2009 and December 31, 2020 where the patient race was either Non-Hispanic White (White) or Non-Hispanic Black (Black) (Figure 1). SI was calculated for a hospital in a year if there were at least 10 White and at least 10 Black patients in that calendar year. When an individual patient had admissions at more than 1 hospital in a year and/or multiple years at the same or different hospitals, a patient was counted once for each hospital-year combination with at least 1 admission. We only included hospitals where we could calculate SI for at least 3 years. We included SI for 96 Hospital-Year combinations (12 unique hospitals).

Study Outcomes and Patient Population

We examined 3 patient-level outcomes: receipt of care by a cardiologist during the admission, 1-year survival following discharge, and all-cause 30-day readmission following discharge. Only patients in hospital-years with a calculated SI were included. Furthermore, we included only the first admission for each patient and only included patients with discharge dates before April 2020 (to ensure a full year of follow-up following discharge). We excluded patients with unknown sex (n=1) and those <18 years of age at admission (n=2). Death was only available as year and month, so for calculating 1-year survival, the date of death was assumed to be the 15th of the month and based on all-cause death. To determine whether a cardiologist saw a patient during the admission, we examined all medical claims associated with that admission and checked the clinician type for all clinicians associated with those claims. A patient was determined to have been seen by a cardiologist during the admission if any claim had 1 of the following CDM designated clinician types: cardiac electrophysiologist, cardiac rehabilitation, cardiologist, cardiology group, cardiovascular disease

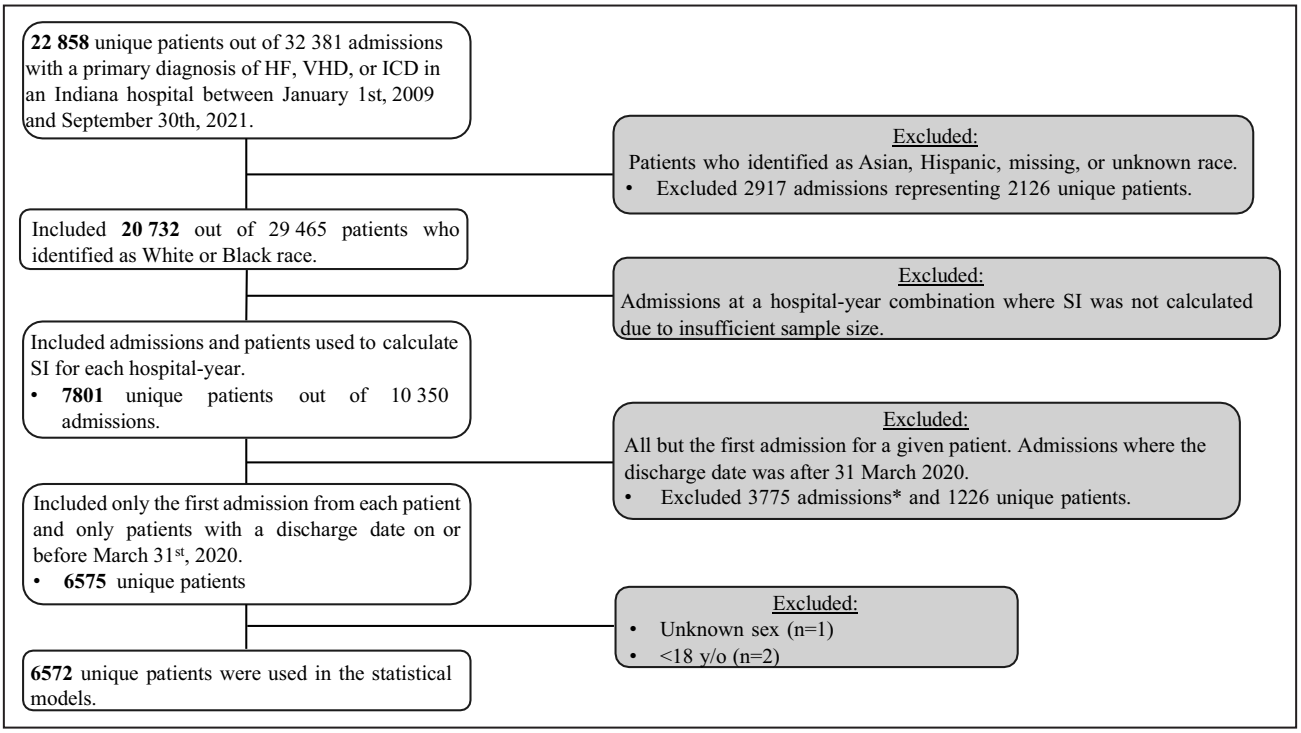

Figure 1. Flow chart for patient selection.
HF indicates heart failure; IHD, ischemic heart disease; SI, segregation index; and VHD, valvular heart disease. *Note that the 3775 admissions excluded represent >1226 unique patients because we are excluding second, third (etc.) admissions for included patients.

specialist, diagnostic cardiology, interventional cardiology, nuclear cardiology, and pediatric cardiologist.

Statistical Analysis

Patient characteristics were summarized using frequency (n) and percent for categorical variables and median and interquartile range for quantitative variables. We compared the characteristics between Black and White patients using Fisher exact test for categorical variables and the Kruskal–Wallis rank sum test for quantitative variables.

Our 3 binary outcomes were analyzed using generalized linear mixed-effects models with a logit-link. Independent variables for the model for receipt of care by a cardiologist included patient race and SI. We initially included a race–SI interaction, but this was not statistically significant (P=0.76), so we removed it for the sake of interpretability. For the models for 1-year survival and 30-day readmission, independent variables included race, SI, and whether the patient received cardiology care, as well as all 2-way and 3-way interactions of patient race, SI, and cardiology care. For the model of 30-day readmission, the 3-way interaction was not significant (P=0.53); thus, this was removed. After removing the 3-way interaction, the only 2-way interaction that was significant was the race–cardiology interaction; therefore, for interpretability, this was the only interaction included in our final model for 30-day readmission. We performed additional sensitivity analyses identical to those in the primary analysis for each of the 3 outcomes: seen by a cardiologist, 1-year survival, and 30-day readmission, on the following subsets of data: admissions post-2012, Medicare beneficiaries, patients with a primary diagnosis of HF, and patients with a primary diagnosis of IHD (Data S1). All models also included the following variables: sex, cubic splines for age at admission and for Charlson Comorbidity Index, and a random hospital-year intercept. Because we had only birth year, not date of birth, age at admission was calculated assuming patients were born on July 1 of their birth year. Charlson Comorbidity Index was calculated following Glasheen et al.[17] All analyses were conducted in R versions 4.1.1. and 4.3.1.[18]

RESULTS

We obtained data specific to White and Black patients hospitalized with a primary diagnosis of HF, IHD, or VHD in Indiana. In total, 6572 patients met our inclusion criteria. Of those, 1127 (17.1%) were Black, and 5445 (82.9%) were White patients (Table 1). The majority of patients were male (56.3%). The median age on admission for Black and White patients was 71 and 73 years, respectively. The primary diagnosis on admission was 36.6% HF, 53.7% IHD, and 9.7% VHD. Hypertension was the most common comorbidity (87.5% Black and 80.7% White patients). Moreover, 50.9% of Black and 41.0% of White patients had diabetes, and 38.8% of Black and 32.7% of White patients had chronic obstructive pulmonary disease. Atrial fibrillation was present among less than one third of patients (21.6% Black and 29.7% White). The median Charlson Comorbidity Index was between 2 and 3 for all racial groups and diseases (Table S2). Among both Black and White patients, coverage by Medicare was more common than coverage by commercial insurance. A higher proportion of Black patients than White patients had Medicare Dual insurance (Medicare and Medicaid) or Medicare Low Income Subsidy. Over the 96 Hospital-Years, SI ranged from 0.323 to 0.693, with considerable variation across years for some hospitals (Figure 2). Sensitivity analysis for each outcome yielded results similar to those of our original analysis (Figures S1 through S3).

Receipt of Care by a Cardiologist

Of the 6572 patients, 6099 (92.8%) were seen by a cardiologist, including 89.0% of Black patients and 93.6% of White patients. After model adjustment, the odds of receiving care by a cardiologist were 31.3% less for Black patients than White patients (adjusted odds ratio (aOR) 0.687 [95% CI, 0.545–0.872] P=0.001). SI, however, was not statistically significantly associated with the odds of receiving care by a cardiologist (per 0.1 increase in SI, the aOR was 0.868 [95% CI, 0.720–1.053]; P=0.14).

One-Year Survival

One-year survival was similar across races, with 78.7% Black and 80.4% of White patients surviving at least 1 year after discharge. The interaction between race, receipt of care by a cardiologist, and SI was statistically significant (P=0.038). For those not seen by a cardiologist, there was no statistically significant change in the aOR (Black:White) of 1-year survival over the span of SI (P=0.20 [ie, the slope of the peach-colored line in Figure 3 is not statistically significantly different from 0]). However, for those seen by a cardiologist, there was a statistically significant change in the aOR of 1-year survival over the range of SI (P=0.02); as illustrated by Figure 3, the odds of 1-year survival for Black patients increased with increasing SI, relative to White patients.

Thirty-Day Readmission

Readmission rates were similar across races, with 16.6% of Black and 15.4% of White patients readmitted within 30 days of discharge. There was a significant interaction between patient race and care by cardiology on 30-day readmission (P=0.01). For those seen by a cardiologist, the odds of 30-day readmission were not significantly different for Black patients compared

Table 1. Patient Characteristics

Demographics	Non-Hispanic Black N=1127	Non-Hispanic White N=5445	*P* value	Total N=6572
Sex				
Male	502 (44.5%)	3198 (58.7%)	<0.001	3700 (56.3%)
Age, y (IQR)	71 (64–79)	73 (66–80)	<0.001	73 (66–80)
Primary diagnosis			<0.001	
HF	596 (52.9%)	1812 (33.3%)		2408 (36.6%)
IHD	484 (42.9%)	3044 (55.9%)		3528 (53.7%)
VHD	47 (4.2%)	589 (10.8%)		636 (9.7%)
Charlson Comorbidity Index (IQR)	3 (2–5)	3 (2–4)	<0.001	3 (2–4)
Comorbidities				
Atrial fibrillation	243 (21.6%)	1615 (29.7%)	<0.001	1858 (28.3%)
COPD	437 (38.8%)	1778 (32.7%)	<0.001	2215 (33.7%)
CKD III–V	313 (27.8%)	1174 (21.6%)	<0.001	1487 (22.6%)
Depression	91 (8.1%)	413 (7.6%)	0.580	504 (7.7%)
Diabetes	574 (50.9%)	2232 (41.0%)	<0.001	2806 (42.7%)
ESRD	72 (6.4%)	139 (2.6%)	<0.001	211 (3.2%)
HTN	986 (87.5%)	4396 (80.7%)	<0.001	5382 (81.9%)
Obesity	281 (24.9%)	1151 (21.1%)	0.006	1432 (21.8%)
Ventricular arrhythmia	85 (7.5%)	453 (8.3%)	0.404	538 (8.2%)
Insurance			<0.001	
Commercial	120 (10.6%)	734 (13.5%)		854 (13.0%)
Medicare	577 (51.2%)	3850 (70.7%)		4427 (67.4%)
Medicare dual	262 (23.2%)	416 (7.6%)		678 (10.3%)
Medicare LIS	163 (14.5%)	434 (8.0%)		597 (9.1%)
Unknown	5 (0.4%)	11 (0.2%)		16 (0.2%)

P values shown are based on Fisher exact test for categorical variables and the Kruskal–Wallis rank sum test for quantitative variables. CKD III–V indicates chronic kidney disease III–V; COPD, chronic obstructive pulmonary disease; ESRD, end-stage renal disease; HF, heart failure; HTN, hypertension; IHD, ischemic heart disease; IQR, interquartile range; LIS, low-income subsidy; and VHD, valvular heart disease.

with White patients (aOR 1.07 [95% CI, 0.89–1.30]; *P*=0.46). However, for patients not seen by a cardiologist, the odds of 30-day readmission were lower for Black patients than for White patients (aOR 0.52 [95% CI, 0.30–0.89]; *P*=0.02). There was no impact of SI on 30-day readmission (*P*=0.86).

DISCUSSION

Among the CDM commercial and Medicare beneficiaries in the state of Indiana, Black patients admitted for HF, IHD, and VHD were less likely to receive care from a cardiologist relative to White patients, irrespective of the SI. For those seen by a cardiologist, 1-year survival for Black patients increased relative to White patients with increasing segregation of the clinician care team. In the absence of a cardiologist on the care team, there was no significant change in relative survival of Black patients compared with White patients over the range of SI observed in our study. SI was not statistically significantly associated with 30-day readmission. For those seen by a cardiologist, the 30-day readmission rate was not statistically significant for Black and White patients. However, when cardiologists were not on the care team, the odds of 30-day readmission were lower for Black patients compared with White patients.

Our findings are similar to other studies that have identified racial differences in survival and readmission for CVD. In 2018 Breathett et al. showed that among a national sample of 104 835 patients admitted to the intensive care unit for HF, Black patients were less likely than White patients to receive care by a cardiologist.[5] Similarly, Hollingsworth et al. studied Medicare beneficiaries with IHD who underwent coronary artery bypass grafting and found that race was associated with survival post–coronary bypass graft surgery according to level of provider care team segregation.[7] VHD studies have also shown racial disparities. Black patients have lower odds of referral to cardiothoracic surgeons and subsequently undergo surgical aortic valve replacement and transcatheter aortic valve replacement less often than White patients.[19–21]

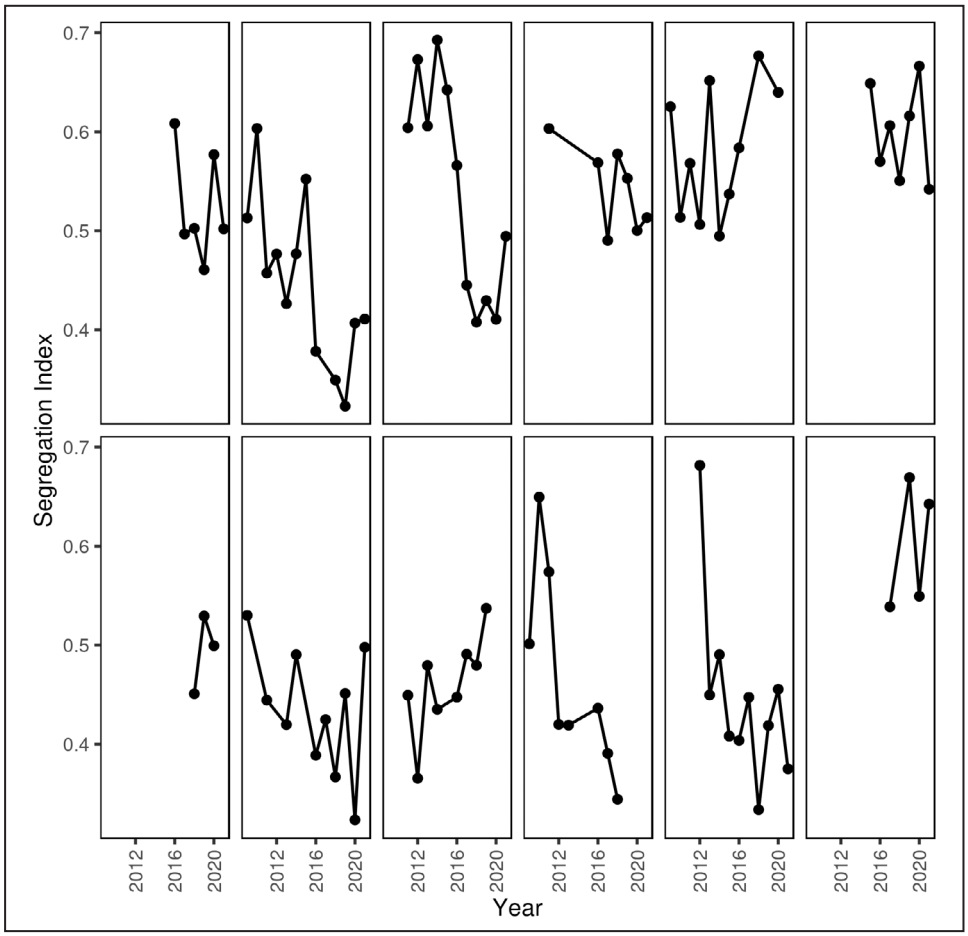

Figure 2. Segregation index over time for individual hospitals.
Each panel represents an individual hospital. Points are shown only for years where SI was calculated. Larger values of the SI indicate more highly segregated care teams. SI indicates segregation index.

Our study differs from others by focusing on clinician SI. Even though SI in itself was not statistically significantly associated with the likelihood of receiving care by a cardiologist, the effect of cardiology care and race on 1-year survival was influenced by SI. These findings may be explained by multiple factors. First, it is well recognized that inclusion of cardiologists is associated with better outcomes,[5,22,23] and it appears that inclusion of a cardiologist may counteract an increasing level of segregation. Second, clinicians who routinely provide care to Black and White patients may be more adept at offering equitable care and perhaps less subject to discriminatory decision-making.[10,24] Third, findings may correspond with the outcomes of the Hospital Readmission Reduction Act where efforts focused on reducing 30-day readmission (to avoid financial penalties) were adversely associated with higher mortality.[25] Data examining the Hospital Readmission Reduction Act were not parsed by clinical teams or inclusion of cardiologists, which may change findings as observed in our study.

The difference between the 2 outcomes can be explained by the different time frames. While there was no statistically significant interaction between SI and 30-day readmission, SI significantly impacted 1-year survival in patients seen by cardiologists. First, the impact of the care team and care by a cardiologist may have a more significant impact over long periods of time. Second, the fact that our findings for 30-day readmission was not affected by SI could imply that efforts are directed toward decreasing readmission rates by improving patient education, discharge planning, and close follow-up with patients. Additionally, our significant 3-way interaction observed for 1-year survival could suggest that ongoing care disparities, such as accessibility to health care, access to subspecialized care, and patient comorbidities, may have a more pronounced impact on the long-term outcomes in Black patients compared with White patients. These findings underscore the need to explore approaches to addressing health disparities while recognizing that interventions may have differing impacts on short versus long-term outcomes in cardiovascular care.

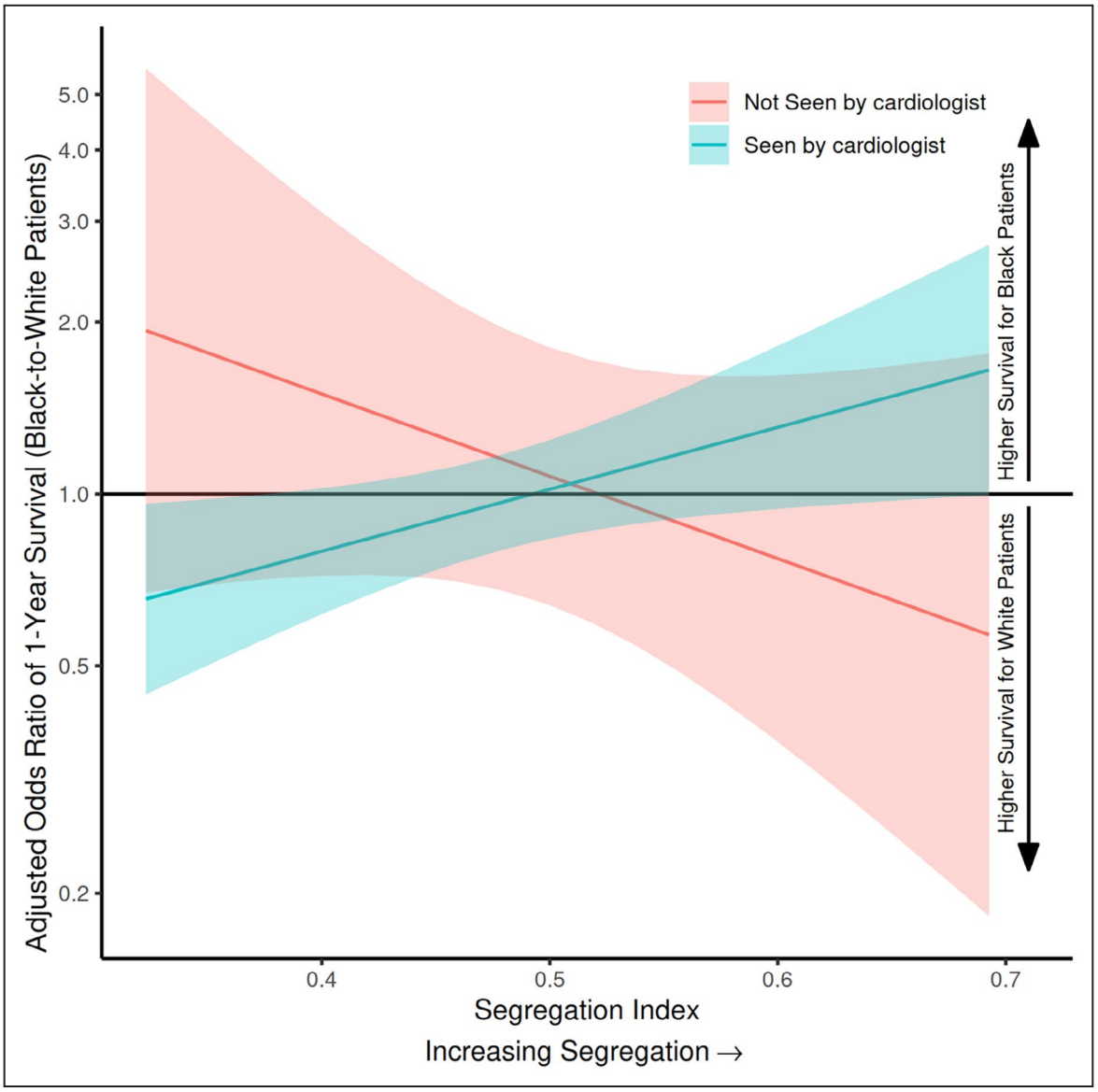

Figure 3. Odds ratio of 1-year survival of Black compared with White patients according to receipt of care by a cardiologist across segregation index.
Odds ratios >1 indicate higher survival for Black patients compared with White patients and are shown with 95% CI bands. Larger values of the segregation index indicate increased clinician care team segregation.

Investigation is needed to develop implementation science strategies to routinely include cardiologists during admissions for primary cardiovascular diseases, particularly for segregated care teams.[26] Structural racism embedded within society has contributed to persistent differences in receipt of care by cardiologists according to patient race.[5,6,27] The relationship between segregated clinician care teams and cardiovascular outcomes are complex. This is a prime opportunity to understand barriers and facilitators to system changes. It should be a priority to use scientific frameworks and theories to identify the best strategies for improving access to a cardiologist.

Limitations

This study was funded to address system care issues for the state of Indiana. While this is 1 of 50 states, demographic representation by race is similar to the United States and generalizable. This study also examines care patterns for adequately insured patients by using the CDM database. As a strength, this study demonstrates how disparities persist with appropriate insurance. We recognize there are other types of social determinants of health and structural racism, such as residential segregation and relation to the hospital type, that can contribute to disparities. The data set did not have this identifiable level of

data to include in our study. Additional investigation is needed to determine how outcomes vary with underinsured populations.

CONCLUSIONS

Among the CDM patients who were admitted for HF, IHD, or VHD in Indiana, this study demonstrates that in the presence of care by a cardiologist, the aOR of 1-year survival increased for Black patients relative to White patients as segregation levels increased. SI was not statistically significantly associated with 30-day readmission. Future investigation should explore the granularity of cardiovascular care patterns to understand how cardiologists are selected for inclusion, how segregation occurs, and how to develop equitable outcomes by race.

ARTICLE INFORMATION

Received October 1, 2024; accepted January 10, 2025.

Affiliations

Department of Internal Medicine, Indiana University, Indianapolis, Indiana (J.Q.B., A.J., S.W.); Indiana University Health, Indianapolis, Indiana (J.Q.B., A.J., S.W., B.T.E., D.J., J.E., B.F., C.B., K.B.); Division of Cardiovascular Medicine, Indiana University, Indianapolis, Indiana (S.M.K., D.T., R.Y., C.B., K.B.); Department of Biostatistics and Health Data Science, Richard M. Fairbanks School of Public Health, Indianapolis, Indiana (S.M.K.); Department of Learning Health Sciences, University of Michigan, Ann Arbor, Michigan (F.W.); School of Nursing, University of Northern Colorado, Greeley, Colorado (N.P.); School of Nursing, University of Texas at Austin, Austin, Texas (M.H.); Sarver Heart Center Minority Outreach Program, University of Arizona, Tucson, Arizona (W.M.); Department of Law and Philosophy, University of Michigan, Ann Arbor, Michigan (E.Y.); Clinical Trials Operations Manager, Indianapolis, Indiana (N.E.); Centers of Wellness for Urban Women, Indianapolis, Indiana (N.K.); Division of Community Networks Collaborations for the East Region, Indianapolis, Indiana (K.L.); Department of Obstetrics and Gynecology, Indiana University, Indianapolis, Indiana (B.T.E.); Department of Medicine, Howard University Medical Center, Washington, DC (Q.C.); Department of Otolaryngology-Head and Neck Surgery and Pediatric Otolaryngology, University of Michigan, Ann Arbor, Michigan (D.B.); Division of Chaplaincy Education, Indiana University Health System, Indianapolis, Indiana (A.H.); Division of Cardiovascular Diseases, University of Michigan, Ann Arbor, Michigan (B.N.); and Quality Department, Endeavor Health NorthShore Hospitals, Evanston, Illinois (J.M.H.).

Acknowledgments

We thank Ms. Johnnie Washington for her contribution to this study.

Sources of Funding

This work was funded by Dr. Breathett's research grant funding from the Health Resources and Services Administration (HRSA) of the US Department of Health and Human Services (HHS). The contents are those of the author(s) and do not necessarily represent the official views of, nor an endorsement by, HRSA, HHS, or the US Government. Dr. Breathett also receives research grant funding from the National Heart, Lung, and Blood Institute (NHLBI) K01HL142848, R56HL159216, and R01HL159216; and Indiana Clinical and Translational Sciences Institute and Indiana University Department of Medicine. The Indiana University Carbonate and Quartz platforms were used to access the Optum's de-identified Clinformatics Data Mart Database (CDM). The platforms are supported in part by Lilly Endowment, Inc., through its support for the Indiana University Pervasive Technology Institute.

Disclosures

None.

Supplemental Material

Data S1. Supplemental Methods
Tables S1–S2
Figures S1–S3

REFERENCES

1. Martin SS, Aday AW, Almarzooq ZI, Anderson CA, Arora P, Avery CL, Baker-Smith CM, Barone Gibbs B, Beaton AZ, Boehme AK, et al. 2024 Heart disease and stroke statistics: a report of US and global data from the American Heart Association. *Circulation*. 2024;149:e347–e913. doi: 10.1161/CIR.0000000000001209
2. Blackston JW, Safford MM, Mefford MT, Freeze E, Howard G, Howard VJ, Naftel DC, Brown TM, Levitan EB. Cardiovascular disease events and mortality after myocardial infarction among black and white adults: REGARDS study. *Circ Cardiovasc Qual Outcomes*. 2020;13:e006683. doi: 10.1161/CIRCOUTCOMES.120.006683
3. Graham G. Population-based approaches to understanding disparities in cardiovascular disease risk in the United States. *Int J Gen Med*. 2014;7:393–400. doi: 10.2147/IJGM.S65528
4. Mathews R, Chen AY, Thomas L, Wang TY, Chin CT, Thomas KL, Roe MT, Peterson ED. Differences in short-term versus long-term outcomes of older black versus white patients with myocardial infarction: findings from the can rapid risk stratification of unstable angina patients suppress adverse outcomes with early implementation of American College of Cardiology/American Heart Association guidelines (CRUSADE). *Circulation*. 2014;130:659–667. doi: 10.1161/CIRCULATIONAHA.113.008370
5. Breathett K, Liu WG, Allen LA, Daugherty SL, Blair IV, Jones J, Grunwald GK, Moss M, Kiser TH, Burnham E, et al. African Americans are less likely to receive care by a cardiologist during an intensive care unit admission for heart failure. *JACC Heart Fail*. 2018;6:413–420. doi: 10.1016/j.jchf.2018.02.015
6. Eberly LA, Richterman A, Beckett AG, Wispelwey B, Marsh RH, Cleveland Manchanda EC, Chang CY, Glynn RJ, Brooks KC, Boxer R, et al. Identification of racial inequities in access to specialized inpatient heart failure care at an Academic Medical Center. *Circ Heart Fail*. 2019;12:e006214. doi: 10.1161/CIRCHEARTFAILURE.119.006214
7. Hollingsworth JM, Yu X, Yan PL, Yoo H, Telem DA, Yankah EN, Zhu J, Waljee AK, Nallamothu BK. Provider care team segregation and operative mortality following coronary artery bypass grafting. *Circ Cardiovasc Qual Outcomes*. 2021;14:e007778. doi: 10.1161/CIRCOUTCOMES.120.007778
8. Breathett K, Spatz ES, Kramer DB, Essien UR, Wadhera RK, Peterson PN, Ho PM, Nallamothu BK. The groundwater of racial and ethnic disparities research: a statement from circulation: cardiovascular quality and outcomes. *Circ Cardiovasc Qual Outcomes*. 2021;14:e007868. doi: 10.1161/CIRCOUTCOMES.121.007868
9. Churchwell K, Elkind MSV, Benjamin RM, Carson AP, Chang EK, Lawrence W, Mills A, Odom TM, Rodriguez CJ, Rodriguez F, et al. Call to action: structural racism as a fundamental driver of health disparities: a presidential advisory from the American Heart Association. *Circulation*. 2020;142:e454–e468. doi: 10.1161/CIR.0000000000000936
10. Breathett K, Jones J, Lum HD, Koonkongsatian D, Jones CD, Sanghvi U, Hoffecker L, McEwen M, Daugherty SL, Blair IV, et al. Factors related to physician clinical decision-making for African-American and Hispanic patients: a qualitative meta-synthesis. *J Racial Ethn Health Disparities*. 2018;5:1215–1229. doi: 10.1007/s40615-018-0468-z
11. Nayak A, Hicks AJ, Morris AA. Understanding the complexity of heart failure risk and treatment in black patients. *Circ Heart Fail*. 2020;13:e007264. doi: 10.1161/CIRCHEARTFAILURE.120.007264
12. Ilonze O, Free K, Breathett K. Unequitable heart failure therapy for black, Hispanic and American-Indian patients. *Card Fail Rev*. 2022;8:e25. doi: 10.15420/cfr.2022.02
13. Tsao CW, Aday AW, Almarzooq ZI, Anderson CAM, Arora P, Avery CL, Baker-Smith CM, Beaton AZ, Boehme AK, Buxton AE, et al. Heart disease and stroke Statistics-2023 update: a report from the American Heart Association. *Circulation*. 2023;147:e93–e621. doi: 10.1161/CIR.0000000000001123
14. Downing NS, Wang C, Gupta A, Wang Y, Nuti SV, Ross JS, Bernheim SM, Lin Z, Normand SLT, Krumholz HM. Association of racial and socioeconomic disparities with outcomes among patients hospitalized

with acute myocardial infarction, heart failure, and pneumonia: an analysis of within- and between-hospital variation. *JAMA Netw Open*. 2018;1:e182044. doi: 10.1001/jamanetworkopen.2018.2044
15. Data. *Social Science Research Commons*. Accessed February 11, 2024. https://ssrc.indiana.edu/data/index.html.
16. Austin AM, Carmichael DQ, Bynum JPW, Skinner JS. Measuring racial segregation in health system networks using the dissimilarity index. *Soc Sci Med*. 1982;2019:112570. doi: 10.1016/j.socscimed.2019.112570
17. Glasheen WP, Cordier T, Gumpina R, Haugh G, Davis J, Renda A. Charlson comorbidity index: ICD-9 update and ICD-10 translation. *Am Health Drug Benefits*. 2019;12:188–197.
18. *R: The R Project for Statistical Computing*. Accessed July 16, 2023. https://www.r-project.org/.
19. Rushing OE, Lillie-Blanton M, Ruiz S, Mayberry R, Boone L. *Racial/Ethnic Differences in Cardiac Care: The Weight of the Evidence*. 2002 https://www.kff.org/wp-content/uploads/2002/09/6040r-racial-and-ethnic-differences-in-cardiac-care-report.pdf.
20. Wilson JB, Jackson LR, Ugowe FE, et al. Racial and ethnic differences in treatment and outcomes of severe aortic stenosis: a review. *JACC Cardiovasc Interv*. 2020;13:149–156. doi: 10.1016/j.jcin.2019.08.056
21. Lamprea-Montealegre JA, Oyetunji S, Bagur R, Otto CM. Valvular heart disease in relation to race and ethnicity: JACC focus seminar 4/9. *J Am Coll Cardiol*. 2021;78:2493–2504. doi: 10.1016/j.jacc.2021.04.109
22. Uthamalingam S, Kandala J, Selvaraj V, Martin W, Daley M, Patvardhan E, Capodilupo R, Moore S, Januzzi JL Jr. Outcomes of patients with acute decompensated heart failure managed by cardiologists versus noncardiologists. *Am J Cardiol*. 2015;115:466–471. doi: 10.1016/j.amjcard.2014.11.034
23. Selim AM, Mazurek JA, Iqbal M, Wang D, Negassa A, Zolty R. Mortality and readmission rates in patients hospitalized for acute decompensated heart failure: a comparison between cardiology and general-medicine service outcomes in an underserved population. *Clin Cardiol*. 2015;38:131–138. doi: 10.1002/clc.22372
24. Chapman EN, Kaatz A, Carnes M. Physicians and implicit bias: how doctors may unwittingly perpetuate health care disparities. *J Gen Intern Med*. 2013;28:1504–1510. doi: 10.1007/s11606-013-2441-1
25. Wadhera RK, Joynt Maddox KE, Wasfy JH, Haneuse S, Shen C, Yeh RW. Association of the hospital readmissions reduction program with Mortality among medicare beneficiaries hospitalized for heart failure, acute myocardial infarction, and pneumonia. *JAMA*. 2018;320:2542–2552. doi: 10.1001/jama.2018.19232
26. Breathett K, Lewsey S, Brownell NK, Enright K, Evangelista LS, Ibrahim NE, Iturrizaga J, Matlock DD, Ogunniyi MO, Sterling MR, et al. Implementation science to achieve equity in heart failure care: a scientific statement from the American Heart Association. *Circulation*. 2024;149:e1143–e1163. doi: 10.1161/CIR.0000000000001231
27. Lewsey SC, Breathett K. Racial and ethnic disparities in heart failure. *Curr Opin Cardiol*. 2021;36:320–328. doi: 10.1097/HCO.0000000000000855