Racial Disparity in Referral for Catheter Ablation for Atrial Fibrillation at a Single Integrated Health System

Jessica M. Duke, MD; Lutfiyya N. Muhammad, PhD, MPH; Jing Song, MS; Yoshihiro Tanaka, MD, PhD; Celeste Witting, MD; Sadiya S. Khan, MD, MSc; Rod S. Passman, MD, MSCE

BACKGROUND: Guidelines recommend catheter ablation of atrial fibrillation (AFCA) as an option for rhythm control. Studies have shown that Black patients are less likely to undergo AFCA compared with White patients. We investigated whether differences in referral patterns play a role in this observed disparity.

METHODS AND RESULTS: Using an integrated repository from the electronic medical record at Northwestern Medicine, we conducted a retrospective cohort study of outpatients with newly diagnosed atrial fibrillation. Baseline characteristics by race and ethnicity were compared. Logistic regression models adjusted for socioeconomic and health factors were constructed to determine the association between race and ethnicity and binary dependent variables including referrals and visits to general cardiology and cardiac electrophysiology (EP) and AFCA. Of 5445 patients analyzed, 4652 were non-Hispanic White (NHW) and 793 were non-Hispanic Black (NHB). In adjusted models, NHB patients initially diagnosed with atrial fibrillation in internal medicine and primary care had a significantly greater odds of referral to general cardiology; among all patients in the cohort, there was no significant difference in the odds of referral to EP between NHB and NHW patients; and there were no differences in the odds of completing a visit in general cardiology or EP. Among patients completing an EP visit, NHB patients were less likely to undergo AFCA (odds ratio, 0.63 [95% CI, 0.40–0.98], P=0.040).

CONCLUSIONS: Similar referral rates to general cardiology and EP were observed between NHB and NHW patients. Despite this, NHB patients were less likely to undergo AFCA.

Key Words: atrial fibrillation • catheter ablation • health care disparities

Atrial fibrillation (AF) is the most common sustained arrhythmia in adults, and its incidence and prevalence are increasing across the globe.1,2 It is associated with a 4- to 5-fold increased risk of stroke and is a major cause of heart failure (HF) and premature death.2 Incidence and prevalence of AF have been previously reported to be lower among non-Hispanic Black patients compared with non-Hispanic White patients despite a higher prevalence of AF risk factors among the former.3-12 Regardless, non-Hispanic Black patients with AF tend to have more symptoms, lower health-related quality of life, and worse disease-related outcomes including death and stroke.13-18

Catheter ablation of AF (AFCA) in patients with symptomatic AF is recommended for those with paroxysmal AF, is considered reasonable for those with persistent AF, and may be considered for those with long-standing persistent AF.19 AFCA may even be considered in select patients with asymptomatic AF, especially in younger individuals and those with HF. It has been previously shown that the maintenance of sinus rhythm by AFCA is associated with a lower risk of stroke and death compared with medical therapy.
CLINICAL PERSPECTIVE

What Is New?

• In adjusted analyses, non-Hispanic Black patients with atrial fibrillation had a significantly greater odds of referral to general cardiology compared with non-Hispanic White patients.
• There was no significant difference in the odds of referral to cardiac electrophysiology between these 2 groups; and there was no significant difference in the odds of completing a visit to either general cardiology or cardiac electrophysiology between these 2 groups.
• Despite an absence of differences in referral patterns, non-Hispanic Black patients were less likely to undergo catheter ablation compared with non-Hispanic White patients after visiting an electrophysiologist.

What Are the Clinical Implications?

• Non-Hispanic Black patients experience greater atrial fibrillation-related symptoms and a greater prevalence of heart failure, 2 features that are indications for rhythm control.
• Atrial fibrillation catheter ablation is superior to drug therapy for rhythm control, especially among minorities.
• Referring patients to subspecialty care is not sufficient to address this disparity in atrial fibrillation care; future studies will need to examine the shared decision-making process for atrial fibrillation management among physicians and patients in order to understand the reason for this disparity so that clinicians may provide equitable care to all patients with atrial fibrillation in accordance with established guidelines.

Nonstandard Abbreviations and Acronyms

| Abbreviation | Definition |
|--------------|------------|
| AFCA         | catheter ablation of atrial fibrillation |
| EMR          | electronic medical record |
| EP           | cardiac electrophysiology |
| IM/PC        | internal medicine/primary care clinic |
| NHB          | non-Hispanic Black |
| NHW          | non-Hispanic White |

and is also associated with reductions in health care use and costs.20,21

Previous studies have shown that non-Hispanic Black patients with AF are less likely to undergo rhythm control with cardioversion, antiarrhythmic drugs, and AFCA.17,22–27 It is unclear if these differences are due, in part, to variability in referral patterns by race and ethnicity. The present study aims to investigate the association between race and ethnicity and referral/visitation patterns in patients with AF.

METHODS

The data that support the findings of this study are available from the corresponding author upon reasonable request. Data were obtained from the Northwestern Medicine Enterprise Data Warehouse, an integrated repository of clinical data from the electronic medical record (EMR) across the Northwestern Medicine system. Data collection was limited to patients diagnosed with AF at a location during an outpatient encounter in the Central Region, which serves the city of Chicago, given the greater racial and ethnic diversity of this area. This study was approved by the Northwestern University Institutional Review Board. The requirement for informed consent was waived.

This was a retrospective cohort study of patients aged ≥18 years who were newly diagnosed with AF in an outpatient visit to internal medicine/primary care (IM/PC), general cardiology, or HF clinic between January 1, 2011 and December 31, 2019. Patients were followed through December 21, 2020. Data collected included date of AF diagnosis, origin of AF diagnosis (IM/PC, general cardiology, or HF), patient’s age at time of AF diagnosis, sex (assigned at birth), race, ethnicity, residential zip code, primary insurance type, height, mass, comorbidities (hypertension, hyperlipidemia, diabetes, acute ischemic stroke, transient ischemic attack, HF, coronary artery disease, peripheral artery disease, chronic kidney disease, dialysis, chronic obstructive pulmonary disease, and obstructive sleep apnea) as identified by International Classification of Diseases, Ninth Revision (ICD-9) and Tenth Revision (ICD-10) codes as billing diagnosis or listed in Past Medical History or Problem List on index date, procedures (AFCA, cardioversion, and dialysis) as identified by Current Procedural Terminology codes, anticoagulant prescription (with patients who had prescriptions for both warfarin and a direct oral anticoagulant listed as direct oral anticoagulant recipients), antiarrhythmic prescription, placement of order for referral to general cardiology, placement of order for referral to cardiac electrophysiology (EP), outpatient visit to general cardiology, and outpatient visit to EP. Body mass index was calculated as mass divided by the square of the height (kg/m²). Residential zip codes were used to map patients with the Distressed Communities Index, a measure of economic well-being based on zip code and US Census data; scores range from 0 (most prosperous) to 100 (most distressed).28

“Referral” indicates that an order was placed in the EMR to direct a patient to subspecialty care. “Visit” indicates that a patient saw a subspecialist in an
outpatient office encounter. Distinguishing between referral and visit is important to determine whether subspecialty care was recommended by the provider ordering the referral versus initiated by the patient.

Patients diagnosed in IM/PC may be referred to and/or visit general cardiology or EP. Patients diagnosed in general cardiology or HF may be referred to and/or visit EP. At our institution, all patients undergoing AFCA must first be seen in the outpatient EP clinic. Patients who received subspecialty referral after initial diagnosis of AF may or may not have a subsequent subspecialty visit; and patients who have a subspecialty visit after initial diagnosis of AF may or may not have received a subspecialty referral before subspecialty visit.

Statistical Analysis
For analytic purposes, we restricted the study sample to patients identified as non-Hispanic Black and non-Hispanic White given the lower numbers of other racial and ethnic groups. Baseline characteristics of the study participants by race and ethnicity were compared using a 2-sample t test for continuous variables and a chi-square test for categorical variables. Separate logistic regression models were constructed to determine the association between race and ethnicity and binary dependent variables. Specifically, the binary outcomes of the separate logistic regression models were referral to general cardiology, visit to general cardiology, referral to EP, visit to EP, and undergoing AFCA. Unadjusted and adjusted logistic regression model findings were summarized using odds ratios (ORs) and associated 95% CIs. Models were adjusted for the sociodemographic and clinical characteristics listed above. Sensitivity analyses were conducted by using Cox proportional hazards regression methods to model time from EP visit to either undergo AFCA or study end date (December 21, 2020); hazard ratio (HR) and associated 95% CIs were summarized. Participants were censored if they did not undergo AFCA during the study duration. Median and range of time from EP visit to undergo AFCA are reported. All analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC) and R.

RESULTS
There were 5502 patients recorded in the Northwestern Medicine Enterprise Data Warehouse as non-Hispanic Black and non-Hispanic White included in the analytic sample with a first diagnosis of AF in the outpatient setting. Patients with incomplete data in outcomes and covariates and those who were listed as having undergone catheter ablation without a prior EP visit were excluded, yielding a final sample size of 5445. Of these, 4652 were non-Hispanic White (85.4%) and 793 were non-Hispanic Black (14.6%) (Table 1). Compared with non-Hispanic White patients, non-Hispanic Black patients were younger on average, a greater proportion were female, and they were more likely to have cardiovascular comorbidities. Non-Hispanic Black patients compared with non-Hispanic White patients were more likely to receive Medicaid and were more likely to live in distressed communities. Non-Hispanic Black patients were more likely to be prescribed warfarin and less likely to be prescribed direct oral anticoagulants compared with non-Hispanic White patients. Non-Hispanic Black patients were less likely to be prescribed antiarrhythmic agents or undergo cardioversion compared with non-Hispanic White patients; these percentages are similar to those reported in the ORBIT-AF (Outcomes Registry for Better Informed Treatment of Atrial Fibrillation) and PINNACLE (Practice Innovation and Clinical Excellence) registries.17,29 Overall, most patients were diagnosed with AF in general cardiology clinic, though a greater proportion of non-Hispanic Black patients were diagnosed in IM/PC and HF clinic compared with non-Hispanic White patients.

Among patients with AF diagnosed in IM/PC, a significantly greater proportion of non-Hispanic Black patients were referred to general cardiology compared with non-Hispanic White patients (43.9% versus 31.9%; OR, 1.67 [95% CI, 1.27–2.19], P < 0.001), but the proportions of non-Hispanic Black and non-Hispanic White patients who visited general cardiology were similar (49.2% versus 47.2%; P = 0.548; Table 2). In the overall cohort, EP referrals were similar between non-Hispanic Black and non-Hispanic White patients (9.1% versus 9.8%; P = 0.525), and a smaller proportion of non-Hispanic Black patients visited EP compared with non-Hispanic White patients (29.3% versus 34.0%; OR, 0.80 [95% CI, 0.68–0.95], P = 0.009). Among patients who visited EP, the proportion of non-Hispanic Black patients who underwent AFCA was significantly lower compared with non-Hispanic White patients (13.8% versus 20.7%; OR, 0.61 [95% CI, 0.41–0.91], P = 0.014), even after excluding patients on dialysis (13.6% versus 20.9%; OR, 0.60 [95% CI, 0.40–0.90], P = 0.013).

In the adjusted regression analyses, non-Hispanic Black patients had a statistically significant greater odds of referral to general cardiology compared with non-Hispanic White patients (Table 2, Figure A), and there was no significant difference in the odds of referral to EP between non-Hispanic White and non-Hispanic Black patients. There were also no significant differences in the odds of visiting general cardiology or EP between non-Hispanic White and non-Hispanic Black patients (Table 2, Figure B). Among patients who visited EP, non-Hispanic Black patients were significantly less likely to undergo AFCA compared with non-Hispanic White patients (OR, 0.63 [95% CI,
### Table 1. Baseline Characteristics of the Study Population

|                                | Total    | Non-Hispanic Black | Non-Hispanic White | P value |
|--------------------------------|----------|---------------------|--------------------|---------|
| **N=5445**                     |          |                     |                    |         |
| Age at index, y, mean (SD)     | 67.68 (13.45) | 65.62 (13.81) | 68.03 (13.36) | <0.001  |
| Men, n (%)                     | 3337 (61.3)  | 389 (49.1)  | 2948 (63.4) | <0.001  |
| Body mass index, kg/m², mean (SD) | 29.08 (6.66) | 30.88 (8.09) | 28.77 (6.34) | <0.001  |
| Health insurance, n (%)        | 143 (2.6)  | 73 (9.2)   | 70 (1.5)   | <0.001  |
| Medicaid                        | 143 (2.6)  | 73 (9.2)   | 70 (1.5)   | <0.001  |
| Medicare                        | 3063 (56.3) | 435 (54.9)  | 2628 (56.5) |         |
| Missing                         | 382 (7.0)  | 64 (8.1)   | 318 (6.8)  |         |
| Private*                        | 1811 (33.3) | 220 (27.7)  | 1591 (34.2) |         |
| Hyperlipidemia, n (%)           | 3209 (58.9) | 487 (61.4)  | 2722 (58.5) | 0.135   |
| Hypertension, n (%)             | 3820 (70.2) | 672 (84.7)  | 3148 (67.7) | <0.001  |
| Diabetes, n (%)                 | 1168 (21.5) | 294 (37.1)  | 874 (18.8)  | <0.001  |
| Heart failure, n (%)            | 2323 (42.7) | 483 (60.9)  | 1840 (39.6) | <0.001  |
| Transient ischemic attack, n (%)| 335 (6.2)  | 67 (8.4)   | 268 (5.8)  | 0.005   |
| Acute ischemic stroke, n (%)    | 580 (10.7)  | 147 (18.5)  | 433 (9.3)  | <0.001  |
| Vascular disease, n (%)         | 2983 (54.8) | 450 (56.7)  | 2533 (54.4) | 0.245   |
| Coronary artery disease, n (%)  | 2453 (45.1) | 381 (48.0)  | 2072 (44.5) | 0.073   |
| Peripheral artery disease, n (%)| 1533 (28.2) | 239 (30.1)  | 1294 (27.8) | 0.193   |
| CHA2DS2-VASc score, mean (SD)   | 3.53 (1.96) | 4.19 (2.02) | 3.41 (1.93) | <0.001  |
| Chronic kidney disease, n (%)   | 939 (17.2)  | 262 (33.0)  | 677 (14.6)  | <0.001  |
| Dialysis, n (%)                 | 126 (2.3)  | 57 (7.2)   | 69 (1.5)   | <0.001  |
| Chronic obstructive pulmonary disease, n (%) | 703 (12.9) | 142 (17.9) | 561 (12.1) | <0.001  |
| Obstructive sleep apnea, n (%)  | 858 (15.8)  | 185 (23.3)  | 673 (14.5)  | <0.001  |
| Distress score, mean (SD)       | 37.97 (26.99) | 67.70 (29.50) | 32.91 (22.98) | <0.001  |
| Anticoagulation, n (%)           | 1919 (35.2) | 278 (35.1)  | 1641 (35.3) |         |
| DOAC†                           | 1868 (34.3) | 244 (30.8)  | 1624 (34.9) |         |
| Warfarin or Coumadin            | 1658 (30.4) | 271 (34.2)  | 1387 (29.8) |         |
| Antiarrhythmic agents, n (%)    |          |                     |                    |         |
| None                            | 3403 (62.5) | 543 (88.5)  | 2860 (61.5) | <0.001  |
| Amiodarone                      | 1488 (27.3) | 199 (25.1)  | 1289 (27.7) | 0.138   |
| Dofetilide                      | 121 (2.2)  | 16 (2.0)   | 105 (2.3)  | 0.770   |
| Dronedarone                     | 206 (3.8)  | 19 (2.4)   | 187 (4.0)  | 0.034   |
| Flecaïnide                      | 193 (3.5)  | 16 (2.0)   | 177 (3.8)  | 0.016   |
| Propafenone                     | 104 (1.9)  | 8 (1.0)    | 96 (2.1)   | 0.062   |
| Sotalol                         | 192 (3.5)  | 25 (3.2)   | 167 (3.6)  | 0.608   |
| Cardioversion, n (%)            | 1047 (19.2) | 103 (13.0)  | 944 (20.3)  | <0.001  |
| Origin of atrial fibrillation diagnosis, n (%) |          |                     |                    | <0.001  |
| General cardiology              | 3711 (68.2) | 463 (58.4)  | 3248 (69.8) |         |
| Heart failure                   | 273 (5.0)  | 66 (8.3)   | 207 (4.4)  |         |
| Internal medicine/primary care   | 1461 (26.8) | 264 (33.3)  | 1197 (25.7) |         |

For normally distributed continuous variables: mean and SD, t test with unequal variance; for categorical variables: n and %, chi-square test. DOAC indicates direct oral anticoagulant.

*Private insurance includes Blue Cross Blue Shield, commercial or managed care, noncontracted/commercial, or insurance provided by the patient’s employer.
†DOAC includes prescription of rivaroxaban (Xarelto), dabigratran (Pradaxa), apixaban (Eliquis), or edoxaban (Savaysa).
Time-to-event analysis results for patients that visited EP before AFCA were consistent with findings from the logistic regression model that assessed the odds of undergoing AFCA between non-Hispanic Black and non-Hispanic White patients. Specifically, for patients who visited EP, non-Hispanic Black patients were less likely to undergo AFCA compared with non-Hispanic White patients (HR, 0.64; [95% CI, 0.44–0.92]; P=0.02). There were 350 patients that underwent AFCA among the 1805 patients whose EP visit occurred before AFCA. The median time to undergo AFCA was 179 days (interquartile range, 47–692 days).

**DISCUSSION**

The results of our study show that differences in referral patterns between non-Hispanic Black and non-Hispanic White patients with AF do not explain the lower rates of AFCA among non-Hispanic Black patients at this single integrated health system. Among patients who visited EP, non-Hispanic Black patients were significantly less likely to undergo AFCA compared with non-Hispanic White patients in the unadjusted and adjusted models.

These findings are important in light of the fact that non-Hispanic Black patients are reported to have greater AF-related symptoms compared with non-Hispanic White patients,\(^\text{14,17}\) and AFCA has been consistently proven to be more effective for rhythm control compared with antiarrhythmic drugs.\(^\text{20,21}\) Furthermore, a recent analysis from the CABANA (Catheter Ablation vs Antiarrhythmic Drug Therapy for Atrial Fibrillation) trial showed that among racial or ethnic minorities enrolled in North America, AFCA significantly improved major clinical outcomes (primary end point: composite of all-cause mortality, disabling stroke, serious bleeding, or cardiac arrest) compared with drug therapy, owing in part to higher adverse event rates seen in minorities treated with antiarrhythmic drugs.\(^\text{30}\) In particular, trials show that among patients with HF, AFCA was associated with a significantly lower rate of death from any cause or hospitalization for HF compared with medical therapy,\(^\text{31}\) and the presence of HF is considered by many to be an indication for rhythm control even in the absence of symptoms.\(^\text{32}\) Given the greater prevalence of HF among non-Hispanic Black patients compared with non-Hispanic White patients in this study, we would expect that more non-Hispanic Black patients would undergo AFCA. Future qualitative research should focus on better understanding the drivers of these differences.

There are many potential explanations for our findings. It is possible that fewer non-Hispanic Black
patients were eligible for AFCA for various reasons not captured in our analysis. Though the regression analyses were adjusted for comorbidities and socio-demographic factors, including insurance status, it is possible that non-Hispanic Black patients in our cohort were less suitable candidates for AFCA for reasons not reliably abstracted from the EMR, such as frailty, which may have prevented the electrophysiologist from recommending AFCA. Though we are unable to retrospectively assess for frailty, we did repeat the analysis after excluding patients on dialysis as there are few available data to support the benefits of ablation in the population with end-stage renal disease, but our results were unchanged. Additionally, our analysis did not differentiate between subtypes of AF (paroxysmal, persistent, permanent); if there are...
differences in the prevalence of AF subtypes between non-Hispanic Black and non-Hispanic White patients in our cohort, this may also explain differences in AFCA as the treatment approach differs between these subtypes. Another possibility is that information may be presented differently by physicians to patients based on race and ethnicity, which may affect whether patients decide to pursue further care, particularly an invasive procedure like AFCA. Indeed, previous studies of patient–physician communication showed that physicians were more verbally dominant and engaged in less patient-centered communication with non-Hispanic Black patients than with non-Hispanic White patients.\(^3^4,^3^5\) that patients in race-concordant visits rated their physicians as more participatory\(^3^6\) and that physician–patient race concordance was associated with a higher use of health services, especially among non-Hispanic White and non-Hispanic Black patients.\(^3^7\) Given that only 3% of cardiologists self-identify as Black,\(^3^8\) and none of the treating electrophysiologists at our center identify as such, we considered this possibility of differential communication and found that although this may partially explain lower rates of AFCA among non-Hispanic Black patients who visited EP compared with non-Hispanic White patients who visited EP, this does not affect subspecialty referral and visit patterns as these were similar between non-Hispanic Black and non-Hispanic White patients. Yet another possibility is that patients may be receiving similar information regardless of race or ethnicity but may opt for different treatment strategies based on cultural values or previous experiences with the healthcare system. In such a case, our results may reflect a difference in patient preference for certain medical interventions. For instance, previous studies of Medicare beneficiaries have found that Black and female patients were more likely to decline cardiac catheterization and coronary angiography than patients who are White and male.\(^3^9,^4^0\) On the other hand, overuse of care by non-Hispanic White patients is another potential explanation. For example, a previous study of percutaneous coronary intervention showed that overuse of this treatment was more common in patients who were male, White, and had private insurance\(^4^1\); it is possible that this may also be the case in the use of AFCA. Finally, the fact that racial and ethnic differences in visits to EP were not statistically significant after controlling for demographic, socioeconomic, and clinical characteristics suggests that these factors play a role in observed differences and points to the need to address the differential impacts of the social determinants of health in society at large. It is worth noting the large difference in Distressed Communities Index scores between non-Hispanic Black and non-Hispanic White patients in our study. The zip-code-level Distressed Communities Index has 7 components: no high school diploma, housing vacancy rate, adults not working, poverty rate, median income ratio, change in employment, and change in business establishments. Given that differences in AFCA persisted in the adjusted model, it is possible that a simple zip-code-level distress score does not sufficiently adjust for individual-level social determinants of health, such as ability to take time off from work, the level of physical activity associated with one’s occupation, and nonwork responsibilities that may be affected by undergoing a procedure. These individual-level considerations may translate to fewer AFCA among non-Hispanic Black patients.

The strengths of our study include a large sample size, which allows us to include a sufficient number of non-Hispanic Black and non-Hispanic White patients to reduce confounding, and the use of a modern real-world database (Northwestern Medicine Enterprise Data Warehouse) to investigate referrals and visits. Our study’s limitations include the use of EMR data, which depend on the accuracy of billing data (ICD-9/10 codes and Current Procedural Terminology codes), though this methodology has been previously validated.\(^4^2\) Additionally, the use of race was based on the EMR, which may be subject to miscoding. Our data source does not allow for differentiation between symptomatic and asymptomatic AF nor does it allow for assessment of eligibility for AFCA and appropriate indications. Although there were differences in the distribution of HF between racial and ethnic groups, information on New York Heart Association Functional Classification and other granular data on HF type were not available in our database. Residual confounding may exist because of unmeasurable confounding factors. Though we focused on referral and visit patterns in the outpatient setting, we cannot rule out the possibility that there may be other unexpected paths to AFCA. Lastly, this study describes a single-system experience that may not be generalizable.

**Conclusions**

In summary, among patients diagnosed with AF in the outpatient setting, non-Hispanic Black patients are less likely to undergo AFCA compared with non-Hispanic White patients. However, this is not explained by differences in referrals to general cardiology or EP in the EMR. Future studies will need to examine the shared decision-making process for AF management among physicians and patients in order to understand the reason for differences in AFCA by race/ethnicity.

**ARTICLE INFORMATION**

Received February 18, 2022; accepted August 11, 2022.

**Affiliations**

Department of Medicine (J.M.D., C.W., S.S.K., R.S.P.); Department of Preventive Medicine (L.N.M., J.S., Y.T., S.S.K., R.S.P.); Center for Arrhythmia

---

**References**

Duke et al. Race and Atrial Fibrillation Ablation. J Am Heart Assoc. 2022;11:e025831. DOI: 10.1161/JAHA.122.025831

7

Duke et al. Race and Atrial Fibrillation Ablation

---

**Corporations**

J Am Heart Assoc. 2022;11:e025831. DOI: 10.1161/JAHA.122.025831
REFERENCES

1. Wyndham CRC. Atrial fibrillation: the most common arrhythmia. Tex Heart Inst J. 2000;27:257–267. doi: 10.1608/tjhm.2007.09.019

2. Kornej J, Borschel C, Benjamin E, Schnabel R. Epidemiology of atrial fibrillation in the 21st century, novel methods, and new insights. Circ Res. 2020;127:4–20. doi: 10.1161/CIRCRESAHA.120.316340.

3. Ugowe FE, Jackson LR, Thomas KL. Racial and ethnic differences in the prevalence, management, and outcomes in patients with atrial fibrillation: a systematic review. Heart Rhythm. 2018;15:1337–1345. doi: 10.1016/j.hrthm.2018.05.019

4. Go AS, Hylek EM, Phillips KA, Chang Y, Henault LE, Selby JV, Singer DE. Prevalence of diagnosed atrial fibrillation in adults: national implications for rhythm management and stroke prevention: the AnTicoagulation and Risk Factor Evaluation (ARISE) study. JAMA. 2001;285:2370–2375. doi: 10.1001/jama.285.18.2370

5. Borzecki AM, Bridges DK, Liebschutz JM, Kader B, Kazis LE, Berlizwitz DR. Racial differences in the prevalence of atrial fibrillation among males. J Natl Med Assoc. 2008;100:237–246. doi: 10.1016/s0027-9684(15)31212-8

6. Alonso A, Agarwal SK, Soliman EZ, Ambrose M, Chamberlain AM, Prineas RJ, Folsom AR. Incidence of atrial fibrillation in whites and African-Americans: the atherosclerosis risk in communities (ARIC) study. Am Heart J. 2009;158:111–117. doi: 10.1016/j.ahj.2009.05.010

7. Amponsah MKO, Benjamin EJ, Magnani JW. Atrial fibrillation and race – a contemporary review. Curr Cardiovasc Risk Rep. 2013;7:356–345. doi: 10.1007/s11886-013-0371

8. Lauer CP, Gbadebo TD, Connolly SJ, Agarwal SK, Soliman EZ, Thomas KL. Trends in cardiovascular mortality related to atrial fibrillation in the United States, 2011 to 2018. J Am Heart Assoc. 2021;10:e020163. doi: 10.1161/JAHA.120.020163

9. Calkins H, Hindricks G, Cappato R, Kim YH, Safar EB, Aguinaga L, Akar A, et al. 2020 AHA/ACC/HRS Focused Update of the HRS/EHRA/ECAS/APHRS/SOLAECE expert consensus statement on catheter and surgical ablation of atrial fibrillation. Circ Res. 2020;126;4–20. doi: 10.1161/HRTHM.2019.11.0125

10. Hunter RJ, McCready J, Diab I, Page SP, Finlay M, Richmond L, French AR, Earley MJ, Spotton S, Jones M, et al. Maintenance of sinus rhythm with an ablation strategy in patients with atrial fibrillation is associated with a lower risk of stroke and death. Heart. 2012;98:48–53. doi: 10.1136/hrt.2011.300720

11. Friedman DJ, Field ME, Rahman M, Goldstein L, Shaq S, Sidharth M, Khanna R, Piccini JP. Catheter ablation and healthcare utilization and cost among patients with paroxysmal versus persistent atrial fibrillation. Heart Rhythm. 2021;12:28–36. doi: 10.1016/j.hrthm.2020.12.017

12. Hoyt H, Nazarian S, Alhumaidhi F, Dalal D, Chilukuri K, Spragg D, Hennikson CA, Sinha S, Cheng A, Edwards D, et al. Demographic profile of patients undergoing catheter ablation of atrial fibrillation. J Cardiovasc Electrophysiol. 2011;22:994–998. doi: 10.1111/j.1540-8167.2011.02043.x

13. Tamariz L, Rodriguez A, Palacio A, Li H, Myerburg R. Racial disparities in the use of catheter ablation for atrial fibrillation and flutter. Clin Cardiol. 2014;37:733–737. doi: 10.1002/ccd.23230

14. Bhave PD, Lu X, Girotra S, Kamel H, Vaughan Sarrazin MS. Race-and sex-related differences in care for patients newly diagnosed with atrial fibrillation. Heart Rhythm. 2015;12:1406–1412. doi: 10.1016/j.hrthm.2015.03.031

15. Kummer BR, Bhave PD, Merkler AE, Gialdini G, O’Brien PM, Kamel H. Demographic differences in catheter ablation after hospital presentation with symptomatic atrial fibrillation. J Am Heart Assoc. 2015;4:e002097. doi: 10.1161/JAHA.115.002097

16. Patel N, Deshmukh A, Thakkar B, Coffey JC, Agnithotri K, Patel A, Ainani N, Nalluri N, Patel N, Patel et al. Gender, race, and health insurance status in patients undergoing catheter ablation for atrial fibrillation. Am J Cardiol. 2016;117:1117–1126. doi: 10.1016/j.amjcard.2016.01.040

17. Bhatia S, Qazi M, Erande A, Shah K, Amin A, Patel P, Malik S. Racial differences in the prevalence and outcomes of atrial fibrillation in patients hospitalized with heart failure. Am J Cardiol. 2016;117:1468–1473. doi: 10.1016/j.amjcard.2016.02.016

18. Distessed Communities Index: 2020 Methodology. Econ Innov Gr. https://eigo.org/doi/cmethodology. Accessed 8/5/2022.

19. Gehi AK, Doros G, Gliorouso TJ, Gursawd GK, Hsu J, Song Y, Turkahia MP, Turchin A, Vrani S, Maddox TM. Factors associated with rhythm control treatment decisions in patients with atrial fibrillation—Insights from the NCDR PINNACLE registry. Am Heart J. 2017;167:86–97. doi: 10.1016/j.amjcard.2017.02.016

20. Thomas KL, Al-Khalidi HR, Silverstein AP, Monahan KB, Bahnson TD, Poole JE, Mark DB, Packer DJ. Ablation versus drug therapy for atrial fibrillation and in atrial fibrillation and ethnic minorities. J Am Coll Cardiol. 2021;78:126–138. doi: 10.1016/j.jacc.2021.04.092

21. Marrouche NF, Brachmann J, Andresen D, Siebers B, Boersma L, Jordaan L, Merkely B, Pokuhashal E, Sanders P, Prof J, et al.
Catheter ablation for atrial fibrillation with heart failure. *N Engl J Med.* 2018;378:417–427. doi: 10.1056/nejmoa1707855

32. January CT, Wann LS, Calkins H, Chen LY, Cigarroa JE, Cleveland JC, Elinor PT, Ezekowitz MD, Field ME, Furie KL, et al. 2019 AHA/ACC/HRS focused update of the 2014 AHA/ACC/HRS guideline for the Management of Patients with Atrial Fibrillation: a report of the American College of Cardiology/American Heart Association task force on clinical practice guidelines and the Heart Rhythm Society in collaboration with the society of thoracic surgeons. *Circulation.* 2019;140:e125–e151. doi: 10.1161/CIR.0000000000000665

33. Turakhia MP, Blankestijn PJ, Carrero JJ, Classé CM, Deo R, Herzog CA, Kasner SE, Passman RS, Pecoits-Filho R, Reinecke H, et al. Chronic kidney disease and arrhythmias: conclusions from a kidney disease: improving global outcomes (KDIGO) controversies conference. *Eur Heart J.* 2018;39:2314–2325e. doi: 10.1093/eurheartj/ehy060

34. Johnson RL, Roter D, Powe NR, Cooper LA. Patient race/ethnicity and quality of patient-physician communication during medical visits. *Am J Public Health.* 2004;94:2084–2090. doi: 10.2105/AJPH.94.12.2084

35. Shen MJ, Peterson EB, Costa-Muniz R, Hernandez MH, Jewell ST, Matsoukas K, Bylund CL. The effects of race and racial concordance on patient-physician communication: a systematic review of the literature. *J Racial Ethn Health Disparities.* 2018;5:117–140. doi: 10.1007/s40615-017-0350-4

36. Cooper LA, Roter DL, Johnson RL, Ford DE, Steinwachs DM, Powe NR. Patient-centered communication, ratings of care, and concordance of patient and physician race. *Ann Intern Med.* 2003;139:907–915. doi: 10.7326/0003-4819-139-11-200312020-00009

37. Laveist TA, Nuru-Jeter A, Jones KE. The association of doctor-patient race concordance with health services utilization. *J Public Health Policy.* 2003;24:312–323. doi: 10.2307/3343378

38. Johnson AE, Talabi MB, Bonifacino E, Culyba AJ, Davis EM, Davis PK, De Castro LM, Essien UR, Maria Gonzalez A, Hogan MV, et al. Racial diversity among American cardiologists: implications for the past, present, and future. *Circulation.* 2021;143:2395–2405. doi: 10.1161/CIRCULATIONAHA.121.053566

39. Heidenreich PA, Shlipak MG, Geppert J, McClellan M. Racial and sex differences in refusal of coronary angiography. *Am J Med.* 2002;113:200–207. doi: 10.1016/S0002-9343(02)01221-4

40. Rathore SS, Ordin DL, Krumholz HM. Race and sex differences in the refusal of cardiac catheterization among elderly patients hospitalized with acute myocardial infarction. *Am Heart J.* 2002;144:1052–1056. doi: 10.1067/mhj.2002.126122

41. Chan PS, Rao SV, Bhatt DL, Rumsfeld JS, Gurm HS, Nallamothu BK, Cavender MA, Kennedy KF, Spertus JA. Patient and hospital characteristics associated with inappropriate percutaneous coronary interventions. *J Am Coll Cardiol.* 2013;62:2274–2281. doi: 10.1016/j.jacc.2013.07.086

42. Jensen PN, Johnson K, Floyd J, Heckbert SR, Carnahan R, Dublin S. A systematic review of validated methods for identifying atrial fibrillation using administrative data. *Pharmacoepidemiol Drug Saf.* 2012;21:141–147. doi: 10.1002/pds