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Regional Variations in Racial Differences in the Treatment of Elderly Patients Hospitalized with Acute Myocardial Infarction

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Abstract

PURPOSE—Racial differences in the treatment of patients with myocardial infarction are often presented as nationally consistent patterns of care, despite known regional variations in quality of care. We sought to determine whether racial differences in myocardial infarction treatment vary by U.S. census region.

METHODS—We conducted a retrospective analysis of medical record data from 138,938 elderly fee-for-service Medicare beneficiaries hospitalized with myocardial infarction between 1994 and 1996. Patients were evaluated for the use (admission, discharge) of aspirin and beta-blockers, and cardiac procedures (cardiac catheterization, any coronary revascularization) within 60 days of admission.

RESULTS—Nationally, black patients had lower crude rates of aspirin and beta-blocker use, cardiac catheterization, and coronary revascularization than did white patients. Racial differences in treatment, however, varied by region. Black patients in the Northeast had rates of aspirin use that were similar to those of white patients on admission (50.6% vs. 49.8%, $P = 0.58$) and at discharge (77.5% vs. 74.2%, $P = 0.07$), whereas racial differences were observed in the South (admission: 43.7% vs. 48.8%, $P < 0.001$; discharge: 69.5% vs. 73.2%, $P < 0.001$), Midwest (admission: 48.4% vs. 52.3%, $P = 0.004$), and West (admission: 49.2% vs. 56.2%, $P < 0.001$; discharge: 70.7% vs. 76.2%, $P = 0.02$). Racial differences in beta-blocker use were comparable across regions (admission: $P = 0.59$, discharge: $P = 0.89$). There were no differences in cardiac catheterization use among black

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and white patients in the Northeast (38.9% vs. 40.5%, $P = 0.24$), as opposed to the Midwest (43.3% vs. 48.9%, $P < 0.001$), South (39.2% vs. 48.5%, $P < 0.001$), and West (38.3% vs. 48.6%, $P < 0.001$). Similarly, racial differences in any coronary revascularization use were smallest in the Northeast (22.1% vs. 26.7%, $P < 0.001$), greater in the Midwest (24.7% vs. 33.5%, $P < 0.001$), and largest in the South (20.7% vs. 32.0%, $P < 0.001$) and West (22.9% vs. 33.7%, $P < 0.001$). Regional variations in racial differences persisted after multivariable adjustment for aspirin on admission ($P = 0.09$) and any coronary revascularization ($P = 0.10$).

CONCLUSION—Racial differences in the use of some therapies for myocardial infarction in patients hospitalized between 1994 and 1996 varied by region, suggesting that national evaluations of racial differences in health care use may obscure potentially important regional variations.

Black patients hospitalized with myocardial infarction receive less intensive medical care and undergo fewer cardiac procedures than do white patients (1–6). Studies have suggested that this pattern of care is not attributable to racial differences in clinical or provider characteristics (1,3). Implicit in these national evaluations is the assumption that these findings represent a national pattern of care. These evaluations generally have not considered the possibility that racial differences in treatment may vary by region, given that the distribution of racial groups and the history of minority access to medical care differ by region (7,8). Indeed, identifying regional variations in racial differences in health care may help focus efforts to ameliorate differences in treatment (9).

The few studies that have assessed regional variations in racial differences in treatment (10–14) have focused only on procedure use and have relied on administrative data. Without accounting for clinical differences between racial groups, it is unclear whether differences in procedure use reflect true regional variations or confounding by geographic variations in patient characteristics. Furthermore, there are little data on differences in the use of medical treatments. We previously found that racial differences in use of acute reperfusion therapy in patients hospitalized with myocardial infarction differed by region (15). Specifically, the overall national pattern of lower rates of reperfusion therapy among black patients primarily reflected racial differences in the treatment of patients in the South. Owing to the paucity of data on differences in other medical treatments for myocardial infarction, we undertook an evaluation of data from the Cooperative Cardiovascular Project (CCP), which includes detailed clinical data and in-hospital medical treatments not available in previous studies, to assess whether racial differences in treatment for myocardial infarction varied by region.

METHODS

Cooperative Cardiovascular Project

The CCP was a Centers for Medicare and Medicaid Services initiative to improve the quality of care for fee-for-service Medicare beneficiaries hospitalized with myocardial infarction (16). We identified 234,769 patients hospitalized in acute care, nongovernmental hospitals in each of the 50 states who had a principal discharge diagnosis of myocardial infarction (*International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM] code 410 [17], excluding readmissions [code 410.x2]) between January 1994 and February 1996. Data on these patients were forwarded to Clinical Data Abstraction Centers for evaluation. Trained medical reviewers abstracted detailed clinical information, including demographic characteristics, medical history, admission characteristics, in-hospital course and treatments, and laboratory and test data; CCP data collection and abstract processes have previously been validated (16). Analysis of the CCP database was approved by the Yale University School of Medicine Human Investigation Committee.

Patients younger than 65 years (n = 17,593), those without clinically confirmed myocardial infarction (n = 31,186), and those with readmissions for myocardial infarction (n = 23,773) were excluded. Patients hospitalized outside of the 50 states and the District of Columbia (n = 1765) and those who arrived by interhospital transfer (n = 42,278) were also excluded to restrict analyses to patients who presented directly to the hospital. Because the principal focus was a comparison of differences in treatment between black and white patients, patients who were not black or white according to the medical record (n = 8951) or who had missing data concerning race (n = 61) were also excluded. These criteria excluded a total of 85,038 hospitalizations, leaving 149,731 patients. Patients with hospital identifiers that could not be linked to the 1994 American Hospital Association Survey (n = 1362), with ZIP code data that could not be linked to the 1990 U.S. Census (n = 2798), with missing Medicare Part A data for their hospitalization (n = 6450), and whose vital status was unknown (n = 214) were subsequently excluded from the baseline sample. In total, 10,793 patients met one or more of these exclusion criteria, resulting in a final sample of 138,938 patients.

Census Region

Patients were divided into one of four census regions based on the state in which they were hospitalized (18): Northeast (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey), South (Delaware, Maryland, District of Columbia, West Virginia, Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Oklahoma, Texas), Midwest (Ohio, Michigan, Indiana, Illinois, Wisconsin, Missouri, Iowa, Minnesota, North Dakota, South Dakota, Nebraska, Kansas), and West (Montana, Idaho, Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada, California, Oregon, Washington, Alaska, Hawaii).

Medical Treatment

Patients were evaluated for the use of four guideline-recommended therapies: aspirin administered within 48 hours of admission, beta-blockers within 48 hours of admission, aspirin prescribed at discharge, and beta-blockers prescribed at discharge (19). To ensure that treatment measures reflected appropriate clinical care, analyses were restricted to patients who were considered to be ‘ideal candidates’ (eligible for therapy with no documented contraindications) for the provision of these therapies (Table 1).

Cardiac Procedures

Patients were evaluated for the use of cardiac procedures by assessing Medicare Part A bills for ICD-9-CM procedure codes indicating that a patient had undergone cardiac catheterization, percutaneous coronary intervention, or coronary artery bypass graft surgery within 60 days after the date of admission. We also evaluated the composite endpoint of percutaneous coronary intervention and coronary artery bypass graft surgery within 60 days of admission to assess use of any coronary revascularization.

Statistical Analysis

Racial differences in age, sex, clinical factors, attending physician characteristics, and attributes of the treating hospital were compared using chi-squared tests or *t* tests, as appropriate. Differences in the proportions of patients classified as ideal candidates for each of the four medical treatments by race were assessed using chi-squared analyses. Crude racial differences in the use of the four medical treatments, cardiac catheterization, any coronary revascularization, coronary artery bypass graft surgery, and percutaneous coronary intervention were assessed using chi-squared analyses in the overall cohort and within each census region. Mantel-Haenszel tests were used to assess whether racial differences in treatment rates varied across the four census regions.

Multivariable logistic regression analyses utilizing generalized estimating equations were conducted to assess whether racial differences in treatment rates were independent of racial or regional differences in patient, physician, or hospital characteristics while accounting for the clustered structure of the sample (i.e., patients clustered within hospitals). Models adjusted for patient characteristics previously associated with treatment, including sex, age, left ventricular function, infarct location, prior revascularization, prior myocardial infarction, diabetes, hypertension, dementia, renal dysfunction, microalbuminuria, anemia, a standing do-not-resuscitate order or other care-limiting directive, admission from a nursing home, functional limitations (mobility and continence), and overall clinical risk (as assessed by the Medicare Mortality Prediction System) (20). Attending physician characteristics included self-reported specialty as documented in the American Medical Association Physician Masterfile and sex. All models also adjusted for hospital characteristics reported in the 1994 American Hospital Association Annual Survey (21), including teaching status, estimated annual myocardial infarction volume, ownership, level of cardiac care facilities (none, cardiac catheterization laboratory only, cardiac surgery capable), and rural location. The assessment of cardiac catheterization use also accounted for patients who received acute reperfusion therapy and patients' appropriateness for cardiac catheterization based on previously published criteria (22). Geographic variations in racial differences in treatment rates were assessed using partial F-tests for the coefficients of the patient race★ census region interaction terms.

Odds ratios were converted to estimated risk ratios (23). Statistical analyses were conducted using the SAS 8.2 (SAS Institute Incorporated, Cary, North Carolina) and Stata 7.0 (Stata Corporation, College Station, Texas) software packages.

RESULTS

Black patients comprised 6.5% (n = 8968) of the overall cohort, with more than half treated in the South (Table 2). Compared with white patients, black patients were younger, and greater proportions were female and had a history of diabetes, hypertension, cerebrovascular disease, renal dysfunction, or functional limitations. A greater proportion of white patients had undergone prior revascularization and had do-not-resuscitate orders. There were no other notable racial differences in clinical characteristics. Black patients were more likely to be treated by a physician who was black, female, and not board certified, whereas white patients were more likely to be treated by a cardiologist. Black patients were treated in greater proportions at public, urban, teaching, and cardiac surgery– capable hospitals.

Medical Treatment

A total of 118,595 patients (7675 black) were classified as ideal candidates for aspirin treatment during hospitalization, 58,547 (3542 black) for beta-blockers during hospitalization, 48,219 (3475 black) for aspirin prescribed at discharge, and 26,155 (1773 black) for beta-blockers prescribed at discharge. Fewer patients were classified as ideal candidates at discharge, primarily because of the exclusion of patients who had died during hospitalization or were transferred out of the admitting hospital. There were no racial differences in the proportion of patients classified as ideal for aspirin on admission overall, although black patients were more likely to be classified as ideal candidates in the South than were white patients (Table 3). Fewer black patients were classified as ideal candidates for beta-blockers on admission, but a greater proportion were classified as ideal candidates for aspirin at discharge and beta-blockers at discharge than were white patients; racial differences in the proportion of patients classified as ideal candidates for these three therapies were generally similar across the four census regions.

Among ideal candidates nationwide, black patients had lower crude rates of aspirin on admission, beta-blockers on admission, aspirin at discharge, and beta-blockers at discharge

than did white patients (Table 4). However, there were significant regional variations in racial differences in treatment for aspirin use both on admission and at discharge. Specifically, for patients treated in the Northeast, there were no statistically significant racial differences in the use of aspirin on admission and a trend towards higher rates of aspirin at discharge among black patients compared with white patients. In contrast, racial differences in these treatments were generally larger in the other regions. Racial differences in the use of beta-blockers did not vary by region.

Although the magnitude of racial differences was attenuated after accounting for patient, physician, and hospital characteristics, racial differences in the use of aspirin on admission by region persisted (Table 5). Black patients in the Northeast continued to have a comparable likelihood of receiving aspirin on admission as white patients, whereas black patients in other regions had lower adjusted likelihoods of treatment ($P = 0.09$ for race★region interaction). There were similar regional variations in racial differences in the prescription of aspirin at discharge, although this finding was not statistically significant ($P = 0.15$ for race★region interaction). There were no regional variations in racial differences in the use of beta-blockers during hospitalization or in prescription at discharge after multivariable adjustment.

Cardiac Procedures

Black patients had lower crude national rates of cardiac catheterization, coronary revascularization, coronary artery bypass graft surgery, and percutaneous coronary intervention than did white patients (all $P < 0.001$; Table 4). Racial differences in cardiac procedure use varied by region. Black patients in the Northeast underwent catheterization at a similar rate as did white patients ($P < 0.001$ for race★region interaction), and racial differences in any coronary revascularization ($P < 0.001$ for race★region interaction), coronary artery bypass graft surgery ($P = 0.012$ for race★region interaction), and percutaneous coronary intervention use ($P = 0.002$ for race★region interaction) were smaller in the Northeast than in any other region. In contrast, racial differences in cardiac procedure use were largest (or among the largest) in the South.

A trend towards geographic variations in racial differences in the use of any coronary revascularization and coronary artery bypass graft surgery persisted after multivariable adjustment, with smaller racial differences in treatment observed among patients in the Northeast and those in other regions (Table 5). In contrast, larger racial differences (or the largest racial difference) in coronary revascularization and coronary artery bypass graft surgery were observed in the South. Racial differences in cardiac catheterization ($P = 0.21$ for race★region interaction) and percutaneous coronary intervention ($P = 0.19$ for race★region interaction) were statistically comparable across the four geographic regions after multivariable adjustment, although smaller racial difference point estimates continued to be observed in the Northeast than in other regions.

DISCUSSION

We found that racial differences in crude rates of aspirin and cardiac procedure use in Medicare patients hospitalized with myocardial infarction varied by region, whereas differences in beta-blocker prescription were comparable across all regions. Although some of these differences were attenuated after multivariable adjustment, regional variations in racial differences persisted for aspirin used on admission, use of any coronary revascularization, and coronary artery bypass graft surgery. These interactions reflected a general pattern of smaller or no racial differences in the Northeast and, in some cases, larger racial differences in the South. These differences, moreover, persisted after accounting for differences in physician or hospital characteristics, suggesting that racial differences in treatment typically assessed at the national level may possibly mask important region-specific practice patterns.

Our findings are similar to those of previous studies that used administrative data (10–13). Racial differences in the use of coronary artery bypass graft surgery, although observed nationwide, were more than twice as large in the seven contiguous states of Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, and South Carolina as compared with any other region in an evaluation of 1986 Medicare data (11). Similarly, racial differences in the use of cardiac catheterization, percutaneous coronary intervention, and coronary artery bypass graft surgery were greatest in the South within the Veterans Affairs health care system (12) and later Medicare cohorts (10,13). Larger racial differences in treatment in the South have also been observed for noncardiac services (10,13). Use of the CCP database provides a methodological advancement over previous studies through the use of detailed clinical data. Moreover, our evaluation of four medical treatments in ideal cohorts permitted characterization of treatment differences as shortfalls in appropriate clinical care. Although our analysis was limited to selected therapies and procedures, our data suggest that, in at least some instances, racial variations in treatment vary by region. These results and those of prior investigators (10–13,15) suggest that national evaluations of racial patterns of care offer an artificial representation of practices that may instead reflect region-specific phenomena.

The presence of smaller or no racial differences in the Northeast may offer important insights into the causes of and remedies for racial variations in treatment. As previous studies have reported, patients hospitalized for myocardial infarction in the Northeast— in particular, New England— have generally higher rates of aspirin and beta-blocker use. If these rates reflect a specific regional culture of evidence-based practice (24), then such an orientation may explain why black patients received similar quality of care as did white patients. Similarly, smaller racial differences in cardiovascular procedure use may be a manifestation of the historically lower rates of cardiovascular procedure use in the Northeast (25). If physicians in the Northeast are more selective in their use of coronary interventions, this may result in their being more likely to avoid overuse of cardiac procedures in white patients. Alternatively, smaller racial differences in the Northeast may reflect ‘structural’ characteristics of the region that were unmeasured in our analysis, such as easier access to hospitals.

Greater differences in treatment in the South may be attributable to factors other than race. One study demonstrated that black patients hospitalized with myocardial infarction in the South reported different symptoms than patients in other regions, suggesting that there may be region-specific cultural differences in patients’ perceptions of symptoms (26). Such racial differences in symptom reporting, if greater in the South, may explain the larger racial differences in some of the treatments assessed. Lower rates of arteriographic evidence of coronary artery disease (27) and myocardial infarction among black patients presenting with chest pain (28,29) may decrease physicians’ suspicions of recurrent cardiac ischemia among black patients postdischarge and thus decrease the use of cardiac procedures. This phenomenon may be more pronounced in the South because of its larger population of black patients.

Distinctive regional characteristics of the South may also explain the larger racial differences in treatment. According to the 2000 U.S. Census, black patients in the South continue to cluster in counties where they comprise near majorities of the population (30). Residence in these areas may exert an ‘environmental’ influence on treatment patterns not accounted for in our evaluation of racial confounding by hospitals. Black patients in the South reside predominantly in rural areas, and minorities in rural areas have historically poorer quality health care than rural white patients or minorities in urban areas (31), although our analysis accounted for treatment in a rural hospital. Racial differences in distrust of the health care system are also higher in the South (32), although it is unclear how issues of trust would influence the use of aspirin and beta-blockers. Racial differences in access to a usual source of care are greatest in the South as well, with black patients reporting higher rates of no usual source of care compared with black patients in the rest of the country (33). Alternatively, if racial differences in acute

myocardial infarction therapy reflect provider bias, then the larger racial disparities in care observed in the South may be an artifact of historically segregated health care (8) or the greater prevalence of prejudicial attitudes toward minority groups in the region (34).

This study has several limitations. First, we used census regions and did not explore variations in treatment in smaller geographic units. Our purpose, however, was not to assess small area variations, but rather to assess whether regional differences in practice patterns may modify racial differences in treatment. There is undoubtedly variation in racial differences in treatment within each of the census regions, but the general absence or smaller size of differences in the Northeast, and larger differences in the use of some treatments in the South, suggest that there are meaningful regional variations that merit further examination. Second, we based our analysis on Medicare fee-for-service beneficiaries hospitalized between 1994 and 1996, and thus our findings may not be generalizable to patients younger than 65 years or those enrolled in Medicare managed care plans, or may not reflect contemporary practice patterns. Third, we did not have access to patient-level socioeconomic data and thus cannot preclude the possibility that racial differences may represent effects attributable to income, education, occupation, or other social status measures. Fourth, we lacked data on supplemental Medicare insurance and thus cannot preclude the possibility that racial differences in treatment reflect variations in insurance, although such differences would also have to vary by region to modify the regional variations in racial differences observed in our study. Finally, because the CCP database does not contain coronary angiography data, we were not able to assess the appropriateness of revascularization based on coronary anatomy. Thus, differences in coronary revascularization use may reflect overtreatment of white patients, under-treatment of black patients, appropriate treatment, or some combination of these processes.

In conclusion, racial differences in crude rates of aspirin and cardiac procedure use among Medicare beneficiaries hospitalized with myocardial infarction varied by U.S. Census region. Although some regional variations in disparate treatment reflected confounding by regional differences in patient and provider characteristics, a general pattern of smaller differences in the Northeast and larger differences in the South were observed for some therapies. These patterns suggest that racial differences in treatment may reflect, in part, region-specific phenomena. Although this hypothesis merits further exploration, our findings indicate that national evaluations of racial differences in treatment may obscure meaningful geographic variations in racially disparate treatment, and thus support the adoption of region-specific analyses.

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Table 1

Exclusion Criteria for Evaluation of Medical Therapies

Aspirin on admission
Admitted by interhospital transfer
Hemorrhage or bleeding before or on admission
History of internal bleeding
History of bleeding disorder
Allergy to aspirin
Terminal illness
Allergy to aspirin
Beta-blockers on admission
Admitted by interhospital transfer
Bradycardia (admission heart rate <50 beats per minute) unless taking a beta-blocker
Heart failure or pulmonary edema on admission
Shock on admission
Hypotension on admission (systolic blood pressure <100 mm Hg)
2nd/3rd-degree heart block on admission
History of heart failure
History of chronic obstructive pulmonary disease
Terminal illness
Allergy to beta-blockers
Aspirin prescribed at discharge
Died during hospitalization
Transferred out of the hospital
Hemorrhage or bleeding during hospitalization
Hemorrhage or bleeding before or on admission
Platelet count during hospitalization $<100 \times 10^3/\mu L$
Hemoglobin <10 mg/dL
Hematocrit <30%
Warfarin prescribed at discharge
History of internal bleeding
History of bleeding disorder
History of peptic ulcer disease
Allergy to aspirin
Reaction or sensitivity to aspirin
Terminal illness
Beta-blockers prescribed at discharge
Died during hospitalization
Transferred out of the hospital
Bradycardia (heart rate <50 beats per minute) unless taking a beta-blocker
Heart failure or pulmonary edema during hospitalization
Heart failure or pulmonary edema on admission
Left ventricular ejection fraction <35%
Shock during hospitalization
Hypotension during hospitalization
Systolic blood pressure <100 mm Hg unless taking a beta-blocker
2nd/3rd-degree heart block during hospitalization
History of heart failure
History of chronic obstructive pulmonary disease
History of peripheral vascular disease
Terminal illness
Allergy to beta-blockers

Table 2

Characteristics of the Study Sample

Characteristic	All Patients (n = 138,938)	White (n = 129,970)	Black (n = 8968)	*P* Value
	Percentage or Median (Interquartile Range)			
Women	49.3	48.6	58.4	<0.001
Age (years)	76 (71–82)	76 (71–82)	74 (69–80)	<0.001
Clinical presentation				
Killip class I/II/III/IV	50/12/35/2	50/12/35/2	47/12/38/2	<0.001
LVEF (%) unknown/<20/20-39/40-54/55	36/2/19/30/12	37/2/19/30/12	35/2/20/31/13	<0.001
Arterial pressure (mm Hg)	101 (89–116)	101 (89–116)	105 (90–120)	<0.001
Heart rate (beats per minute)	85 (71–102)	85 (71–101)	88 (72–105)	<0.001
Anterior infarction	46.6	46.6	47.6	0.08
Q-wave infarction	59.7	59.9	57.6	<0.001
ST-segment elevation infarction	29.2	29.3	27.8	0.004
Heart failure on chest radiograph	23.9	23.9	24.1	0.71
Medical history				
Hypertension	61.5	60.3	78.7	<0.001
Diabetes mellitus	30.2	29.4	42.0	<0.001
Prior myocardial infarction	29.3	29.4	28.4	0.05
Current smoker	14.7	14.5	17.9	<0.001
Cerebrovascular disease	14.0	13.7	18.4	<0.001
Peripheral vascular disease	10.7	10.6	12.6	<0.001
Prior CABG	12.4	12.8	6.3	<0.001
Prior PTCA	6.4	6.6	4.7	<0.001
Dementia	6.1	6.0	8.1	<0.001
Microalbuminuria	4.5	4.4	6.7	<0.001
Anemia	7.0	6.7	11.3	<0.001
Chronic obstructive pulmonary disease	20.5	20.7	17.6	<0.001
Renal insufficiency	12.5	12.0	19.8	<0.001
Independent mobility	78.5	79.0	70.5	<0.001
Incontinent, aneuric, or other urinary problems	9.7	9.4	14.2	<0.001
Admitted from a nursing home	6.8	6.8	7.0	0.60
DNR order before admission	9.6	9.8	6.3	<0.001
Physician characteristics				
Race				<0.001
White	54.6	55.3	44.6	
Black	1.0	0.6	7.1	
Other	11.8	11.7	13.1	
Unknown	32.5	32.3	35.3	
Sex				<0.001
Male	85.0	85.3	81.4	
Female	5.8	5.7	7.7	
Unknown	9.2	9.0	10.9	
Board certification				<0.001
Yes	74.1	74.5	69.3	
No	16.8	16.6	19.8	
Unknown	9.1	9.0	10.9	
Years in practice	18 (12–25)	18 (12–25)	18 (13–25)	0.03
Years in practice unknown	9.1	9.0	10.9	
Specialty				<0.001
Cardiology	30.8	31.1	26.6	
Medicine subspecialty	11.1	10.9	14.4	
Internal medicine	25.5	25.5	25.7	
Family/general practice	18.6	18.7	17.1	
Other	14.0	13.9	16.1	
Hospital characteristics				
Ownership				< 0.001
Public	12.3	11.9	18.1	
Not-for-profit	77.4	77.8	72.2	
For-profit	10.2	10.3	9.7	
Teaching status				< 0.001
Nonteaching hospital	67.0	68.0	52.1	
GME-affiliated	21.6	21.4	24.0	
COTH hospital	11.4	10.5	23.9	
Level of cardiac care facilities				< 0.001
Unknown	7.8	7.9	6.5	
No invasive facilties	29.9	30.2	25.7	
Catheterization available	26.1	26.2	24.1	
CABG available	36.2	35.7	43.7	
Annual myocardial infarction volume	132 (70–225)	134 (70–226)	120 (63–207)	< 0.001
Rural location	21.7	22.1	16.7	< 0.001
Geographic location				< 0.001
Northeast	25.6	26.2	16.6	
South	37.0	35.8	55.5	

Characteristic	All Patients (n = 138,938)	White (n = 129,970)	Black (n = 8968)	*P* Value
	Percentage or Median (Interquartile Range)			
Midwest	22.4	22.6	20.1	
West	15.0	15.4	7.8	

CABG = coronary artery bypass graft surgery; COTH = Council of Teaching Hospitals; DNR = do-not-resuscitate; GME = graduate medical education; LVEF = left ventricular ejection fraction; PTCA = percutaneous transluminal coronary angioplasty.

Table 3

Treatment Eligibility Rates

	Entire Cohort	Northeast	South	Midwest	West	*P* for Interaction
	Percentage					
Aspirin on admission						0.002
Overall	85.4	85.9	84.9	84.7	86.5	
White	85.3	85.9	84.7	84.8	86.6	
Black	85.6	84.5	86.6	83.7	85.4	
P value	0.54	0.12	<0.001	0.21	0.39	
Beta-blockers on admission						0.47
Overall	42.1	39.7	42.6	43.2	43.5	
White	42.3	39.8	42.9	43.4	43.7	
Black	39.5	38.6	39.7	39.5	39.6	
P value	<0.001	0.38	<0.001	0.001	0.03	
Aspirin at discharge						0.08
Overall	34.7	36.3	32.8	32.1	40.6	
White	34.4	36.2	32.2	31.8	40.5	
Black	38.8	39.8	38.5	35.9	45.4	
P value	<0.001	0.005	<0.001	<0.001	0.01	
Beta-blockers at discharge						0.75
Overall	18.8	17.0	18.6	19.0	22.2	
White	18.8	17.0	18.4	19.0	22.2	
Black	19.8	17.1	19.7	20.5	23.9	
P value	0.02	0.96	0.02	0.11	0.28	

Table 4

Crude Treatment Rates, Overall and by Region

	Entire Cohort	Northeast	South	Midwest	West	*P* Value
			Percentage			
Aspirin on admission (no. of subjects [no. of black patients])	118,595 [7675]	30,536 [1256]	43,681 [4313]	26,401 [1509]	17,977 [597]	0.002
Overall	50.7	49.8	48.3	52.1	55.9	
White	51.0	49.8	48.8	52.3	56.2	
Black	46.2	50.6	43.7	48.4	49.2	
P value	<0.001	0.58	<0.001	0.004	<0.001	
Race difference (95% confidence interval)	−4.8 (−6.0 to −3.6)	0.8 (−2.0 to 3.6)	−5.1 (−6.7 to −3.5)	−3.9 (−6.5 to −1.3)	−6.9 (−11.0 to −2.8)	
Relative risk★ (95% confidence interval)	0.90 (0.88 to 0.93)	1.02 (0.96 to 1.07)	0.90 (0.86 to 0.93)	0.93 (0.88 to 0.98)	0.88 (0.81 to 0.95)	
Aspirin at discharge (no. of subjects [no. of black patients])	48,219 [3475]	9593 [591]	16,875 [1919]	9994 [494]	8442 [317]	0.002
Overall	74.5	74.3	72.8	76.4	76.0	
White	74.7	74.2	73.2	76.4	76.2	
Black	72.2	77.5	69.5	76.2	70.7	
P value	0.002	0.08	<0.001	0.93	0.03	
Race difference (95% confidence interval)	−2.4 (−4.0 to −0.9)	3.3 (−0.1 to 6.8)	−3.7 (−5.9 to −1.5)	−0.2 (−3.6 to 3.2)	−5.6 (−10.6 to −0.5)	
Relative risk★ (95% confidence interval)	0.97 (0.95 to 0.99)	1.04 (1.00 to 1.09)	0.95 (0.92 to 0.98)	1.00 (0.95 to 1.04)	0.93 (0.86 to 1.00)	
Beta-blockers on admission (no. of subjects [no. of black patients])	58,547 [3542]	14,120 [574]	21,923 [1979]	13,459 [712]	9045 [277]	0.59
Overall	47.8	56.7	43.8	45.9	46.7	
White	48.1	56.8	44.1	46.0	46.7	
Black	43.9	53.8	40.5	44.4	46.6	
P value	<0.001	0.16	0.002	0.41	0.97	
Race difference (95% confidence interval)	−4.2 (−5.9 to −2.5)	−3.0 (−7.2 to 1.2)	−3.6 (−5.9 to −1.4)	−1.6 (−5.3 to 3.2)	−0.1 (−6.1 to 5.8)	
Relative risk★ (95% confidence interval)	0.91 (0.88 to 0.95)	0.95 (0.88 to 1.02)	0.92 (0.87 to 0.97)	0.96 (0.89 to 1.05)	1.00 (0.88 to 1.14)	
Beta-blockers at discharge (no. of subjects [no. of black patients])	26,155 [1773]	6061 [254]	9543 [983]	5934 [369]	4617 [167]	0.85
Overall	52.1	62.6	47.2	50.3	50.7	
White	52.4	62.8	47.6	50.4	50.8	
Black	47.8	58.7	44.2	49.6	48.5	
P value	<0.001	0.18	0.05	0.78	0.57	
Race difference (95% confidence interval)	−4.6 (−7.0 to −2.2)	−4.2 (−10.3 to 2.0)	−3.3 (−6.6 to 0.0)	−0.8 (−6.0 to 4.5)	−2.3 (−10.0 to 5.4)	
Relative risk★ (95% confidence interval)	0.91 (0.87 to 0.96)	0.93 (0.84 to 1.04)	0.93 (0.86 to 1.00)	0.98 (0.88 to 1.09)	0.96 (0.81 to 1.12)	
Other treatments (no. of subjects [no. of black patients])	138,938 [8968]	35,555 [1486]	51,439 [4980]	31,163 [1803]	20,781 [699]	
Cardiac catheterization within 60 days						<0.001
Overall	46.1	40.4	47.6	48.5	48.3	
White	46.5	40.5	48.5	48.9	48.6	
Black	39.9	38.9	39.2	43.3	38.3	
P value	<0.001	0.24	<0.001	<0.001	<0.001	
Race difference (95% confidence interval)	−6.6 (−7.6 to −5.5)	−1.6 (−4.1 to 1.0)	−9.3 (−10.7 to −7.8)	−5.6 (−8.0 to −3.2)	−10.3 (−14.0 to −6.6)	

	Entire Cohort	Northeast	South	Midwest	West	*P* Value
			Percentage			
Relative risk★ (95% confidence interval)	0.86 (0.83 to 0.88)	0.96 (0.90 to 1.03)	0.80 (0.78 to 0.84)	0.88 (0.84 to 0.93)	0.79 (0.72 to 0.87)	
Any coronary revascularization within 60 days						<0.001
Overall	30.6	26.5	30.9	33.0	33.3	
White	31.2	26.7	32.0	33.5	33.7	
Black	21.9	22.1	20.7	24.7	22.9	
P value	<0.001	<0.001	<0.001	<0.001	<0.001	
Race difference (95% confidence interval)	−9.2 (−10.2 to −8.4)	−4.5 (−6.9 to −2.4)	−11.2 (−12.4 to −10.0)	−8.8 (−10.8 to −6.7)	−10.8 (−14.0 to −7.6)	
Relative risk★ (95% confidence interval)	0.70 (0.68 to 0.73)	0.83 (0.75 to 0.91)	0.65 (0.61 to 0.68)	0.74 (0.68 to 0.80)	0.68 (0.59 to 0.78)	
Percutaneous coronary intervention within 60 days						0.002
Overall	17.6	14.0	17.6	19.6	20.8	
White	17.9	14.0	18.1	19.9	21.0	
Black	13.0	12.8	12.2	14.3	15.0	
P value	<0.001	0.21	<0.001	<0.001	<0.001	
Race difference (95% confidence interval)	−4.9 (−5.6 to −4.2)	−1.2 (−2.9 to 0.6)	−5.9 (−6.8 to −4.9)	−5.6 (−7.2 to −3.9)	−6.0 (−8.7 to −3.3)	
Relative risk★ (95% confidence interval)	0.72 (0.69 to 0.77)	0.92 (0.80 to 1.05)	0.68 (0.63 to 0.73)	0.72 (0.64 to 0.81)	0.71 (0.60 to 0.85)	
Coronary artery bypass graft surgery within 60 days				0.01		
Overall	14.0	13.2	14.2	14.6	13.9	
White	14.3	13.3	14.8	14.8	14.1	
Black	9.4	9.8	8.8	11.2	8.3	
P value	<0.001	<0.001	<0.001	<0.001	<0.001	
Race difference (95% confidence interval)	−4.9 (−5.5 to −4.3)	−3.6 (−5.1 to −2.0)	−6.0 (−6.8 to −5.1)	−3.7 (−5.2 to −2.2)	−5.8 (−7.9 to −3.7)	
Relative risk★ (95% confidence interval)	0.66 (0.62 to 0.70)	0.73 (0.62 to 0.86)	0.60 (0.54 to 0.65)	0.75 (0.66 to 0.86)	0.59 (0.46 to 0.76)	

★Black versus white patients.

Table 5

Race and Likelihood of Treatment, Overall and by Region

	Overall	Northeast	South	Midwest	West	*P* Value
	Relative Risk★ (95% Confidence Interval)					
Aspirin on admission						
Unadjusted	0.91 (0.88–0.93)	1.00 (0.94–1.06)	0.89 (0.85–0.92)	0.93 (0.88–0.99)	0.88 (0.81–0.94)	0.006
Patient characteristics†	0.94 (0.91–0.96)	1.02 (0.96–1.09)	0.93 (0.89–0.97)	0.95 (0.90–1.01)	0.92 (0.85–0.99)	0.07
Patient, physician‡, hospital§ characteristics	0.95 (0.93–0.98)	1.02 (0.96–1.09)	0.93 (0.90–0.97)	0.94 (0.89–1.00)	0.92 (0.85–1.00)	0.09
Aspirin at discharge						
Unadjusted	0.97 (0.94–0.99)	1.04 (0.98–1.09)	0.95 (0.92–0.98)	0.99 (0.94–1.04)	0.93 (0.86–1.00)	0.03
Patient characteristics†	0.98 (0.96–1.00)	1.05 (0.99–1.10)	0.97 (0.94–1.01)	1.00 (0.95–1.04)	0.95 (0.89–1.02)	0.09
Patient, physician‡, hospital§ characteristics	0.99 (0.97–1.01)	1.05 (0.99–1.10)	0.97 (0.94–1.01)	0.99 (0.94–1.04)	0.96 (0.89–1.02)	0.15
Beta-blockers on admission						
Unadjusted	0.93 (0.89–0.97)	0.96 (0.89–1.04)	0.92 (0.87–0.98)	0.96 (0.87–1.04)	0.96 (0.83–1.09)	0.92
Patient characteristics†	0.92 (0.88–0.96)	0.95 (0.88–1.03)	0.92 (0.87–0.98)	0.95 (0.86–1.04)	0.95 (0.81–1.08)	0.97
Patient, physician‡, hospital§ characteristics	0.94 (0.90–0.98)	0.95 (0.88–1.02)	0.93 (0.88–0.99)	0.94 (0.85–1.03)	0.95 (0.82–1.09)	0.99
Beta-blockers at discharge						
Unadjusted	0.93 (0.88–0.98)	0.96 (0.86–1.06)	0.93 (0.86–1.00)	0.98 (0.86–1.09)	0.91 (0.75–1.08)	0.91
Patient characteristics†	0.92 (0.88–0.97)	0.95 (0.84–1.05)	0.94 (0.86–1.01)	0.97 (0.85–1.09)	0.91 (0.76–1.08)	0.96
Patient, physician‡, hospital§ characteristics	0.95 (0.89–1.00)	0.95 (0.83–1.05)	0.95 (0.88–1.02)	0.95 (0.84–1.06)	0.91 (0.75–1.08)	0.97
Cardiac catheterization within 60 days of admission						
Unadjusted	0.84 (0.81–0.87)	0.92 (0.86–1.00)	0.80 (0.78–0.84)	0.87 (0.82–0.93)	0.85 (0.78–0.94)	0.004
Patient characteristics†	0.83 (0.80–0.86)	0.88 (0.80–0.96)	0.82 (0.78–0.85)	0.83 (0.77–0.89)	0.79 (0.70–0.88)	0.19
Patient, physician‡, hospital§ characteristics	0.82 (0.79–0.85)	0.86 (0.79–0.94)	0.81 (0.78–0.85)	0.79 (0.74–0.85)	0.77 (0.68–0.86)	0.21
Any coronary revascularization within 60 days of admission						
Unadjusted	0.69 (0.67–0.73)	0.81 (0.72–0.90)	0.64 (0.60–0.68)	0.75 (0.67–0.83)	0.74 (0.64–0.83)	<0.001
Patient characteristics†	0.67 (0.63–0.69)	0.75 (0.66–0.84)	0.63 (0.58–0.67)	0.68 (0.61–0.75)	0.68 (0.58–0.79)	0.04
Patient, physician‡, hospital§ characteristics	0.66 (0.63–0.69)	0.74 (0.65–0.84)	0.63 (0.60–0.68)	0.66 (0.59–0.74)	0.68 (0.58–0.80)	0.10
Coronary artery bypass graft surgery within 60 days of admission						
Unadjusted	0.66 (0.61–0.70)	0.73 (0.61–0.86)	0.60 (0.54–0.66)	0.75 (0.65–0.86)	0.62 (0.49–0.76)	0.03
Patient characteristics†	0.62 (0.57–0.66)	0.66 (0.56–0.79)	0.57 (0.52–0.63)	0.68 (0.59–0.79)	0.56 (0.44–0.72)	0.14
Patient, physician‡, hospital§ characteristics	0.60 (0.56–0.65)	0.65 (0.54–0.78)	0.56 (0.50–0.62)	0.68 (0.59–0.80)	0.60 (0.46–0.77)	0.10
Percutaneous coronary intervention within 60 days of admission						
Unadjusted	0.71 (0.66–0.76)	0.88 (0.73–1.05)	0.66 (0.60–0.72)	0.74 (0.63–0.86)	0.76 (0.64–0.91)	0.02
Patient characteristics†	0.74 (0.69–0.79)	0.87 (0.73–1.04)	0.71 (0.65–0.78)	0.72 (0.61–0.83)	0.78 (0.64–0.94)	0.19
Patient, physician‡, hospital§ characteristics	0.73 (0.68–0.78)	0.85 (0.71–1.00)	0.72 (0.66–0.78)	0.68 (0.58–0.79)	0.76 (0.63–0.90)	0.19

★Relative likelihood of black patients receiving treatment as compared with white patients.

†Patient characteristics include sex, age, left ventricular function, infarct location, prior revascularization, prior myocardial infarction, diabetes, hypertension, dementia, renal dysfunction, microalbuminuria, anemia, a standing do-not-resuscitate order or other care-limiting directive, admission from a nursing home, continence, limited mobility, Medicare Mortality Prediction System score, and cardiac catheterization appropriateness (cardiac catheterization within 60 days of admission only).

[‡]Physician characteristics include the attending physician’s self-reported specialty and sex.

[§]Hospital characteristics include teaching status, estimated annual myocardial infarction volume, ownership, cardiac care facilities, and location in a rural area.