Special Article

RACIAL DIFFERENCES IN THE USE OF CARDIAC CATHETERIZATION AFTER ACUTE MYOCARDIAL INFARCTION

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ABSTRACT

Background Several studies have reported that black patients are less likely than white patients to undergo cardiac catheterization after acute myocardial infarction. The role of the race of the physician in this pattern is unknown.

Methods We analyzed data from the Cooperative Cardiovascular Project, a study of Medicare beneficiaries hospitalized for acute myocardial infarction in 1994 and 1995, to evaluate whether differences between black patients and white patients in the use of cardiac catheterization within 60 days after acute myocardial infarction varied according to the race of their attending physician.

Results Our study cohort consisted of 35,676 white and 4039 black patients with acute myocardial infarction who were treated by 17,550 white and 588 black physicians. Black patients had lower rates of cardiac catheterization than white patients, regardless of whether their attending physician was white (rate of catheterization, 38.4 percent vs. 45.7 percent; $P<0.001$) or black (38.2 percent vs. 49.6 percent, $P<0.001$). We did not find a significant interaction between the race of the patients and the race of the physicians in the use of cardiac catheterization. The adjusted mortality rate among black patients was lower than or similar to that among white patients for up to three years after the infarction.

Conclusions Racial differences in the use of cardiac catheterization are similar among patients treated by white physicians and those treated by black physicians, suggesting that this pattern of care is independent of the race of the physician. (N Engl J Med 2001;344:1443-9.)

NUMEROUS studies have reported that black patients with coronary artery disease are less likely than white patients to undergo cardiac catheterization.[1-9] Many aspects of the physician–patient relationship that may account for treatment decisions have been described.[10] Factors associated with a difference in race between physicians and patients, such as cross-cultural miscommunication,[11,12] lack of rapport or trust,[13,14] and reduced willingness on the part of the patient to undergo an intervention,[15] may lead to the use of fewer procedures among black patients. Alternatively, bias on the part of physicians — due to subconscious perceptions, incorrect assumptions regarding the preferences of patients, or overt discrimination — may contribute to racial differences in the use of cardiac catheterization.[16,17] However, whether racial differences in the use of cardiac catheterization vary according to the race of the physician is unknown.

In previous studies, it has been observed that patients treated by physicians of a race other than their own participated less in decision making[13] and may have been less willing to consider cardiac interventions than patients whose physicians were of the same race as themselves.[15] We sought to examine whether the race of the physician contributes to racial differences in the use of cardiac catheterization. We hypothesized that if racial differences in the use of cardiac catheterization were associated with the race of the physician, then differences between black patients and white patients in the rate of cardiac catheterization would vary according to the race of the physician. We analyzed data from patients in the national Cooperative Cardiovascular Project to assess whether differences in the rate of cardiac catheterization and in survival after acute myocardial infarction were related to differences between the race of physicians and the race of patients.

METHODS

Patients

We performed a retrospective analysis of data from the Cooperative Cardiovascular Project, a Health Care Financing Administration quality-improvement initiative for patients with acute myocardial infarction.[18] The Cooperative Cardiovascular Project consisted of data on 234,769 hospitalizations among Medicare patients on a fee-for-service basis in 1994 or 1995 and had a discharge diagnosis of acute myocardial infarction (code 410 of the *International Classification of Diseases, 9th Revision, Clinical Modification* [ICD-9-CM]).[19] Patients with the following characteristics were excluded from our study: age of less than 65 years (17,591 patients); absence of a clinically confirmed diagnosis of acute myo-

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cardial infarction (defined as documentation in the patient's chart of either a serum creatine kinase MB fraction above 0.05, a serum lactate dehydrogenase level more than 1.5 times the upper limit of normal, with the level of isoenzyme 1 exceeding the level of isoenzyme 2, or at least two of the following three conditions: chest pain, a serum creatine kinase level more than double the upper limit of normal, or evidence of a new acute myocardial infarction on an electrocardiogram) (31,179); previous percutaneous transluminal coronary angioplasty or coronary-artery bypass graft surgery (43,143); concurrent terminal illness (4616); hospitalization after transfer from another acute care hospital (42,277); readmission (25,185); unavailability of Medicare Part A data at time of analysis (34,187); or hospitalization outside the 50 United States (1760). Patients whose data could not be linked with American Hospital Association data were also excluded (2363). Some patients met more than one of the exclusion criteria. Of the remaining 118,953 patients, the cohort we considered was limited to the 75,893 patients in hospitals that had admitted at least 1 black patient with acute myocardial infarction in the Cooperative Cardiovascular Project during the study period.

Data on physicians were successfully matched for 73,846 of these 75,893 patients (97.3 percent), although data on the physician's race were not available for 24,452 of the 75,893 patients (32 percent). Patients with cardiovascular surgeons as attending physicians (1806 patients) were excluded because many of them were probably undergoing elective coronary-artery bypass graft surgery. The following patients were also excluded: patients whose race could not be confirmed as either white or black (2324), and patients who were treated by physicians who were neither white nor black (9106). Some patients met more than one of these exclusion criteria.

Dependent Variables

We evaluated Medicare Part A billing records for the use of cardiac catheterization (procedure codes 37.22, 37.23, and 88.53 through 88.57 of ICD-9-CM) within 60 days after admission with acute myocardial infarction. We ascertained death within three years after admission with acute myocardial infarction by supplementing information on vital status in the Cooperative Cardiovascular Project with data from the Death Master File of the Social Security Administration.[20]

Independent Variables

Race of the Patients and Physicians

The race of the patients in the Cooperative Cardiovascular Project was abstracted from medical records. The race of the attending physicians was identified with use of their unique physician identification numbers as recorded in Medicare Part A claims. The attending physician is regarded as "the clinician who is primarily and largely responsible for the care of the patient from the beginning of the hospital episode."[21] We linked the identification numbers of the attending physicians with the Physician Masterfile of the American Medical Association. The Physician Masterfile is a comprehensive, validated data base of information on physicians' characteristics,[22] collected from medical school matriculation forms, surveys of physicians, and residency training programs (Havlicek PL: personal communication).

Other Independent Variables

Because the severity of disease and the presence of coexisting illnesses influence the decision to use cardiac catheterization, we adjusted for the following predictive variables (based on published studies[23-26]) and clinically relevant factors: age; sex; Killip class at the time of admission; left ventricular ejection fraction; systolic blood pressure; heart rate; anatomical site of the acute myocardial infarction; presence or absence of a history of previous acute myocardial infarction or congestive heart failure; current smoking status; presence or absence of hypertension, diabetes mellitus, stroke, peripheral vascular disease, or renal dysfunction (blood urea nitrogen above 40 mg per deciliter [14 mmol per liter] or serum creatinine level above 2.0 mg per deciliter [177 μmol per liter]); and use or nonuse of thrombolytic therapy. We also adjusted for several nonclinical factors: characteristics of the hospitals, according to the American Hospital Association 1994 survey of hospitals (teaching status, ownership, and availability of on-site facilities for cardiac procedures)[27]; characteristics of the physicians, according to the American Medical Association Physician Masterfile (specialty, sex, decade of graduation, country of medical school, employment type, and type of training [osteopathic or allopathic]); and number of the physician's patients enrolled in the Cooperative Cardiovascular Project. Hospital volume (estimated from Medicare Part A data) and patients' income and education level (from 1990 U.S. Census data[28]) were classified into quintiles.

The survival analyses included the presence or absence of the following additional factors: inability to walk, urinary incontinence, dementia, admission from a nursing home, chronic obstructive pulmonary disease, liver disease, infection with the human immunodeficiency virus or other immunologic compromise, trauma within the previous month, a serum albumin level below 3 g per deciliter, a hematocrit below 30 percent, and use of aspirin, beta-blockers or angiotensin-converting–enzyme inhibitors during hospitalization or prescribed at discharge. Dummy variables indicating missing values were included in the multivariate analyses.

Statistical Analysis

Differences in the characteristics of the patients, the rate of cardiac catheterization, and mortality were assessed by means of chi-square tests for categorical variables and analysis of variance for continuous variables. We examined whether racial differences in the rate of cardiac catheterization or in survival persisted after adjustment for differences in the characteristics of the patients, the physicians, and the hospitals through a series of multivariate logistic-regression models. The effect of the race of the physician on differences between black patients and white patients in the use of cardiac catheterization was examined with the use of models incorporating interaction terms. We transformed odds ratios to relative risks by the method of Zhang and Yu.[29] We used Cox proportional-hazards regression models to assess the relative risks of death. All the regression models incorporated Huber–White robust standard errors, adjusted for clustering according to physician.[30] We used Stata statistical software (version 6.0, Stata, College Station, Tex.) to conduct the analyses.

RESULTS

Patients

Our cohort consisted of 35,676 white and 4039 black Medicare beneficiaries who were treated for acute myocardial infarction by 17,550 white physicians and 588 black physicians. The mean ($\pm$SD) age of the patients was 77$\pm$7.6 years (range, 65 to 108). Blacks represented 9 percent of the patients treated by white physicians and 53 percent of the patients treated by black physicians. Black patients were more likely to have hypertension, diabetes mellitus, renal dysfunction, previous heart failure, stroke, or peripheral vascular disease than white patients, regardless of the race of their physicians (Table 1). Other clinical characteristics of the two groups of patients were generally similar, whether they were treated by white or black physicians. Black patients were less likely to have board-certified cardiologists as attending physicians, were more likely to be treated in public or teaching hospitals, and on average lived in neighborhoods with lower levels of income and education than white patients, regardless of the race of their physicians.

TABLE 1. CHARACTERISTICS OF THE PATIENTS.*

CHARACTERISTIC	WHITE PHYSICIANS		BLACK PHYSICIANS	
	WHITE PATIENTS (N=35,176)	BLACK PATIENTS (N=3476)	WHITE PATIENTS (N=500)	BLACK PATIENTS (N=563)
Age (yr)	77.3±7.6	75.9±7.6†	76.6±7.3‡	76.1±7.5
Female sex (%)	47.5	41.2†	50.2	35.0§¶
Clinical history (%)				
Hypertension	60.4	77.9†	62.2	82.1§¶
Diabetes mellitus	28.7	41.2†	29.4	42.5§
Previous myocardial infarction	23.8	25.1	21.2	22.7
Previous heart failure	20.8	25.5†	19.6	27.5§
Current smoker	14.7	18.3†	18.2‡	17.9
Previous stroke	13.5	18.5†	11.4	18.5§
Peripheral vascular disease	10.1	11.6†	10.4	13.3
Characteristics on admission (%)				
Systolic blood pressure <100 mm Hg	7.2	7.0	9.2	8.0
Pulse >100 beats/min	26.6	29.3†	27.0	31.3
Renal dysfunction	11.8	20.9†	11.6	18.7§
Site of infarction				
Anterior	47.9	47.1	46.8	48.1
Inferior	46.9	44.1†	47.6	43.2
Left ventricular ejection fraction				
≥55%	13.1	13.0	15.4	13.5
40–54%	32.5	29.6†	27.0‡	30.7
20–39%	19.9	19.6	22.4	21.0
<20%	1.7	2.2†	1.8	2.8
Unknown	32.8	35.7†	33.4	32.0
Medications used during hospitalization or at discharge (%)				
Aspirin	80.9	79.8	77.2‡	75.7¶
Beta-blockers	47.8	43.8†	47.6	39.4§
Thrombolytic agents	18.3	13.5†	22.0‡	12.8§
Angiotensin-converting–enzyme inhibitors	38.1	43.1†	35.4	41.9§
Specialty of attending physician (%)				
Internal medicine	24.2	21.9†	26.6	24.2
Cardiology	27.2	23.9†	30.8	12.3§¶
Other internal-medicine subspecialty	11.0	13.5†	7.0‡	7.1¶
Family practice	15.4	16.3	12.2	14.0
Characteristics of hospital (%)				
Cardiac catheterization available	70.9	66.6†	63.4	68.2§
Teaching	41.7	46.5†	31.8‡	49.2§
Public	11.0	21.0†	10.2	19.7§
Private, not-for-profit	79.8	69.0†	80.0	70.7§
Socioeconomic characteristics				
Annual household income ($)	31,738±11,851	23,697±9,308†	28,571±9,575‡	22,953±8,791§
Population with at least a high-school diploma (%)	50.1	41.1†	47.0‡	40.5§

*Plus–minus values are means ±SD.

†P<0.05 for the comparison between black patients treated by white physicians and white patients treated by white physicians.

‡P<0.05 for the comparison between white patients treated by black physicians and white patients treated by white physicians.

§P<0.05 for the comparison between black patients treated by black physicians and white patients treated by black physicians.

¶P<0.05 for the comparison between black patients treated by black physicians and black patients treated by white physicians.

Use of Cardiac Catheterization

We found that black patients were significantly less likely than white patients to undergo cardiac catheterization within 60 days after admission, regardless of whether their attending physicians were white or black (P<0.001 for both comparisons) (Table 2). The rate of cardiac catheterization among white patients did not differ significantly according to whether their physicians were white or black (45.7 percent and 49.6 percent, respectively; P=0.08). Similarly, the rate of cardiac catheterization among black patients did not differ significantly according to whether their physicians were white or black (38.4 percent and 38.2 percent, respectively; P=0.94).

Table 2. Rate of Use of Cardiac Catheterization within 60 Days after Acute Myocardial Infarction among Black Patients and White Patients, According to the Race of Their Physicians.*

Rate	White Physicians		Black Physicians	
	white patients (n=35,176)	black patients (n=3476)	white patients (n=500)	black patients (n=563)
	percent (95 percent confidence interval)			
Unadjusted	45.7	38.4†	49.6	38.2†
Adjusted	45.7‡	32.9 (30.1–36.1)§	53.4 (43.4–65.8)	36.5 (29.2–45.2)¶

*In the adjusted analyses, adjustments were made for the characteristics of the patients, the physicians, and the hospitals. There were no significant differences in the rates of cardiac catheterization among either the white patients or the black patients according to the race of their physicians.

†$P<0.001$ for the comparison between black patients and white patients, regardless of the race of their physician.

‡These patients served as the reference group.

§$P<0.001$ for the comparison between black patients treated by white physicians and white patients treated by white physicians.

¶$P=0.04$ for the comparison between black patients treated by black physicians and white patients treated by black physicians.

In analyses that adjusted for the characteristics of the patients, the physicians, and the hospitals, black patients remained less likely to undergo cardiac catheterization than white patients treated by white doctors, regardless of the race of the black patients' attending physicians (Table 2). The difference between white patients and black patients in the adjusted rates of cardiac catheterization was 12.8 percentage points (45.7 percent and 32.9 percent, respectively) among those treated by white doctors and 16.9 percentage points (53.4 percent and 36.5 percent) among those treated by black doctors. In multivariate analyses of the use of cardiac catheterization, we did not find a significant interaction between the patient's race and the physician's race ($P=0.73$), indicating that black patients treated by black physicians did not undergo cardiac catheterization at a different rate from black patients treated by white physicians.

Mortality

Unadjusted 30-day mortality rates were lower among black patients than among white patients, regardless of the race of their attending physicians (Table 3). By the end of three years, unadjusted mortality rates were higher among black patients than among white patients, regardless of the race of their physicians. In multivariate analyses, however, 30-day mortality rates were significantly lower among black patients — both those treated by white physicians and those treated by black physicians — than among white patients treated by white physicians (Table 4). Three-year adjusted mortality rates among black patients treated by white physicians were also lower than the rates among white patients treated by white physicians; the same was true of black patients treated by black physicians as compared with white patients treated by white physicians. The results were consistent when analyses were limited either to patients who underwent cardiac catheterization or to those who did not undergo the procedure.

Table 3. Unadjusted Mortality among Black Patients and White Patients, According to the Race of Their Physicians.*

Follow-up	White Physicians		Black Physicians	
	white patients	black patients	white patients	black patients
	percent			
30 days	19.4	17.3†	20.4	18.5
1 yr	32.8	33.1	31.2	36.8
2 yr	40.0	41.1	38.2	44.9‡
3 yr	46.0	48.5†	43.2	52.4‡

*There were no significant differences in the mortality rates among either the white patients or the black patients according to the race of their physicians.

†$P<0.05$ for the comparison between black patients treated by white physicians and white patients treated by white physicians.

‡$P<0.05$ for the comparison between black patients treated by black physicians and white patients treated by black physicians.

DISCUSSION

Our findings are consistent with those of previous studies that reported differences between white and

TABLE 4. ADJUSTED MORTALITY AMONG BLACK PATIENTS AND WHITE PATIENTS, ACCORDING TO THE RACE OF THEIR PHYSICIANS.*

FOLLOW-UP	WHITE PHYSICIANS		BLACK PHYSICIANS	
	WHITE PATIENTS	BLACK PATIENTS	WHITE PATIENTS	BLACK PATIENTS
	hazard ratio (95% CI)			
30 Days	1.00	0.78 (0.72–0.86)	0.99 (0.79–1.25)	0.74 (0.59–0.92)
1 Yr	1.00	0.87 (0.81–0.93)	0.91 (0.76–1.08)	0.88 (0.76–1.03)
2 Yr	1.00	0.87 (0.82–0.93)	0.91 (0.78–1.06)	0.89 (0.77–1.02)
3 Yr	1.00	0.89 (0.84–0.95)	0.90 (0.79–1.04)	0.91 (0.80–1.03)

*Adjustments were made for the characteristics of the patients, the physicians, and the hospitals. CI denotes confidence interval. White patients treated by white physicians served as the reference group.

black Medicare beneficiaries[7] and other white and black populations[1-6,8,9] in the rate of cardiac catheterization. In addition, our study found that black patients underwent cardiac catheterization less frequently after acute myocardial infarction than white patients, regardless of the race of their physicians. The absence of an interaction between the race of the patient and the race of the physician suggests that racial discordance between the patient and the physician does not explain differences between black patients and white patients in the use of cardiac catheterization.

What factors could potentially explain the lower rate of use of cardiac catheterization in black patients, regardless of the physician's race? Differences in clinical characteristics among races are one possible explanation. Black patients are less likely than white patients to describe typical chest pain after acute myocardial infarction[12,31] and are more likely to have nondiagnostic electrocardiograms at the time of presentation.[6] These factors might reduce the likelihood that black patients will undergo cardiac catheterization, although they would be expected to be less important once the diagnosis of acute myocardial infarction has been confirmed.

It is possible that black patients may be less willing than white patients to undergo cardiac procedures because of different thresholds for procedure-related risks, different levels of trust in the medical system, or different degrees of familiarity with these treatments.[14,15] In previous studies, black patients were more likely to refuse to undergo cardiac procedures than white patients.[32] Conversely, white patients may be more aggressive in seeking such procedures. Other interactions between patients and physicians that are related to race may also play a part in ways that have not yet been defined.[13]

Unmeasured or unmeasurable differences in socioeconomic factors may also have contributed to the lower rate of cardiac procedures among blacks, regardless of the race of their physicians. Although we adjusted for income and education according to local U.S. Census data, we cannot exclude the possibility of residual confounding due to heterogeneity of these factors within neighborhoods. Furthermore, although Medicare paid the hospital bills of all the patients in our study, there still may have been differences in their ability to pay for care. For example, our study was unable to assess the effects of supplemental "Medigap" insurance, which pays for outpatient visits, medications, or out-of-pocket expenses, including deductibles and copayments. Because nonwhite Medicare beneficiaries are less likely to have supplemental insurance than white beneficiaries,[33] the prospect of incurring substantial out-of-pocket costs may have been a strong disincentive to undergoing cardiac catheterization. Important social factors, such as the availability of family support, may also have an important role. For example, it has been reported that patients who are married may be more likely to undergo a cardiac procedure than those who are not married,[1] and according to the same study, blacks are less likely to be married than whites.

Whether differences in the rate of cardiac procedures between black patients and white patients are associated with differences in outcomes is uncertain. Several studies found that black patients have poorer long-term survival after acute myocardial infarction than white patients.[34,35] Other studies showed that although blacks underwent fewer cardiac procedures, their survival after hospitalization for acute myocardial infarction was equivalent to or better than that of whites.[1,4,6,7] We found that 30-day mortality rates were lower in blacks than in whites, and this trend, though it diminished, persisted up to three years of follow-up.

Differences in the unmeasured clinical characteristics of patients of different races are one potential reason why blacks may have had a lower rate of death after acute myocardial infarction than white patients.

Nonwhite race is associated with failure to hospitalize for acute myocardial infarction,[36] and if black patients with more severe infarctions died before admission, the proportion of hospitalized black patients with less severe infarctions would be greater than that of hospitalized white patients.[37] Studies showing that blacks have higher rates of out-of-hospital death from infarction[38] and cardiac arrest[39] are consistent with this hypothesis. Although it is not clear whether the differences in mortality according to race in our study were due to differences in the clinical characteristics or medical treatment of the patients, our findings do not support the hypothesis that the lower rate of use of cardiac catheterization in black patients is associated with worse survival.

Given the design of our study, we were unable to assess whether cardiac procedures were underused, appropriately used, or overused in either black patients or white patients. We were also unable to examine potential interactions between the patients and the specialists consulted by attending physicians who were not cardiologists. However, the decision to initiate consideration for catheterization by requesting consultation with a cardiac specialist or by transferring the patient to an outside hospital with a cardiac catheterization laboratory is typically the responsibility of the attending physician. We were unable to evaluate the decision to refer a patient for catheterization because we examined only the actual use of the procedure. Finally, we cannot rule out the possibility that institutional factors and attitudes common to black and white physicians contribute to lower rates of cardiac catheterization in black patients than in white patients. Despite these limitations, our findings indicate that there is no interaction between the race of the physician and the race of the patient in the use of cardiac catheterization. The observation that racial differences in the use of cardiac catheterization are similar among patients treated by black physicians and white physicians suggests that racial discordance between patients and physicians does not explain racial differences in the use of this procedure.

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