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Clinical and Nonclinical Correlates of Racial and Ethnic Differences in Recommendation Patterns for Coronary Revascularization

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Summary

Background: We sought to determine whether gender or racial differences exist in recommendations for coronary revascularization in a multiracial patient population undergoing their first coronary angiography at an academic institution from 1990–1993 for the evaluation of coronary artery disease (CAD).

Hypothesis: For patients with clinically significant CAD, no racial differences exist in the recommendation to revascularization following coronary angiography.

Methods: The main outcome measure was a recommendation for coronary revascularization such as percutaneous transluminal coronary angioplasty (PTCA) or coronary artery bypass graft (CABG) for patients with clinically significant CAD (n = 590). The primary multiple logistic regression analysis focused on only those patients with angiographically severe disease, defined as triple-vessel or left main CAD (n = 180). Race was trichotomized into Hispanic, black, and white to ascertain whether any differential effects of race/ethnicity existed while controlling for age, gender, ejection fraction, angina, diabetes, hypertension, and peripheral vascular disease. A medical record review for all patients with severe CAD, who were given a recommendation for medical therapy, was conducted to ascertain whether previously unmeasured clinical factors or nonclinical factors may have precluded a PTCA/CABG recommendation.

Results: Hispanics with severe disease were significantly less likely than whites to be given a recommendation for PTCA/CABG following angiography [odds ratio (OR) = 0.39; 95% confidence interval (CI) (0.17, 0.92)]. Blacks were 67% as likely as whites to be given such a recommendation [OR = 0.67; 95% CI (0.17, 2.71)]. Medical records, reviewed for 35 of 40 of these patients given a recommendation for medical therapy, revealed that 6 patients eventually had PTCA/CABG within 6 months due to precipitating ischemic events; 9 had such severe or diffuse disease that revascularization did not appear to be an alternative, and 2 patients opted for medical therapy.

Conclusions: Racial differences were manifested in the recommendations made following angiography and may be explained by previously unmeasured clinical as well as nonclinical factors.

Key words: revascularization, recommendations, coronary disease, nonclinical factors, racial

Study Background/Rationale

Coronary artery disease (CAD) remains the leading cause of mortality among all Americans.[1,2] However, the use of diagnostic and therapeutic procedures for coronary disease has been shown to differ by race and gender.[1,3–8] The explanations proposed for this variation are limited and often come from secondary analyses of large administrative databases, which may have significant limitations including being fraught with multiple errors, discrepancies in diagnostic coding, and limited clinical data regarding the severity of the coronary anatomy.[3,9,10] Differential utilization patterns for invasive diagnostic and therapeutic procedures for managing ischemic heart disease may exist because of differences in clinical appropri-

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ateness of the procedures, patient preference for noninvasive or invasive procedure(s), differences in the recommendation for these procedures, or changes in treatment recommendation following discussion with the patients or their families.[6, 11–14]

There are limited data regarding the actual treatment recommendation for invasive cardiac procedures following coronary angiography.[12–14] Perhaps differential rates of use of invasive cardiac procedures represent differences in the actual treatment recommendation made to patients following angiography. Schulman *et al.* recently reported the results of an experiment using actors as patients with ischemic heart disease symptoms to ascertain the physicians' recommendation for coronary angiography.[15] Black women were less likely to be given a recommendation for angiography by the physicians who completed a computerized survey. However, this experiment was based on hypothetical scripted scenarios and not on clinical case vignettes. Thus, this experiment may not represent the true clinical decision-making of these physicians who were neither cardiologists nor were they randomly recruited to participate. Leape *et al.* retrospectively evaluated the underuse of and recommendation to coronary revascularization (PTCA or CABG) among New York City patients who received angiography in 1992 and found that the highest rate of underuse (26%) was among patients at hospitals that did not provide PTCA or CABG.[11] However, this retrospective study only examined patients that met standardized criteria for necessary revascularization, thereby excluding patients in whom revascularization might still be clinically appropriate and potentially improve the quality of their lives. Also, the medical records reviewed contained no standard documentation statements of revascularization recommendations following angiography. Therefore, the researchers asked cardiologists whether revascularization was recommended to the study patients.

The purpose of this study was to determine whether there were racial or gender differences in the recommendation to revascularization following angiography for the multiethnic, multiracial patient population referred to an inner-city hospital for cardiac catheterization.

Methods

Study Population

Following Institutional Review Board approval, the study sample included 827 patients who underwent coronary angiography for the first time, primarily for the evaluation of ischemic heart disease during 1990–1993, at the Jack D. Weiler Hospital of the Albert Einstein College of Medicine (Weiler). Patients were excluded from the analysis for the following reasons: a history of prior cardiac catheterization, prior angioplasty or bypass surgery, presence of congenital or hypertensive heart disease, significant aortic or mitral valve disease, congestive heart failure, cardiomyopathy, and primary pulmonary hypertension. These patients were excluded only on the basis of their medical diagnoses and without regard to their sociodemographic or economic factors. Patients found to have either normal coronary arteries (n = 207) or clinically insignificant coronary lesions (<50% stenosis) following angiography were included for descriptive analyses of the overall patient population undergoing their first cardiac catheterization in the evaluation of ischemic heart disease at our institution. Nonwhites included African Americans (n = 97), Hispanics (n = 183), and others (n = 24). Although Hispanics and blacks represent a diverse culture/ethnicity, they were categorized as nonwhites for analytical purposes only. The race of 30 persons could not be identified, therefore descriptive analyses performed according to race included 797 patients.

Data Collection

To minimize bias, study data were collected from instruments incorporated into the standard cardiac catheterization pre- and postprocedural assessment forms that were already in use at the time of the study and collected information on patients' medical history, catheterization results, as well as treatment recommendations. The preprocedural forms were completed routinely by the cardiology fellows, physician assistants, housestaff, and attending physicians on all patients admitted for cardiac catheterization. Information available to the cardiologist at the time of angiography included all medical information collected in the precatheterization work-up, such as patients' demographics, presenting symptoms, cardiac risk factors, presence of comorbid conditions, prior cardiac history, exercise tolerance test results, and current medications used. The angiographic results and therapeutic recommendations were collected and entered onto the postcardiac catheterization form used routinely only by the attending catheterization physician. This form included information regarding treatment recommendations post angiography. Recommendations made were in one of the following categories: (1) medical therapy, (2) bypass surgery, (3) angioplasty, (4) either medical therapy or revascularization, and (5) medical therapy with further evaluation.

Recommendations for treatment may not always reflect the treatment that is ultimately given. Therefore, to assess whether the original medical treatment recommendations were the actual treatment received, we conducted a medical record review for all patients with severe coronary artery disease who were given a recommendation for medical therapy. Specifically, we wanted to ascertain whether previously unmeasured clinical or nonclinical factors may have precluded recommendation for revascularization for some of these patients.

Definition of Dependent Variable

Recommendations were made by the cardiologist who performed the procedure with knowledge of the patient's general medical and cardiac history. There were four attending cardiologist/angiographers at the time of this study, including the director of catheterization, who performed procedures as well. Recommendations for coronary revascularization were made by review of cineangiograms, with graphic and numeric depiction of the anatomic findings, considering a diameter steno-

sis of ≥ 50% as significant vessel disease. The stenosis severity was determined by caliper-assisted measurement of individual arteries by the attending cardiologist performing the catheterization. The decision to recommend a particular therapy was achieved by a consensual discussion, which took place face-to-face or by telephone between the diagnostic and the referring cardiologist or the internist. However, it is the practice of the institution that invasive cardiologists are responsible for the care of the patients admitted to the hospital (including same-day procedures) for the entire period surrounding the catheterization. Therefore, all cardiologists were well aware of all medical problems pertaining to the patients. The study was ongoing and was unknown to all but the head/director of the catheterization laboratory.

Institutional preferences for the recommendation of therapy were as follows: Only lesions > 60% were considered appropriate for angioplasty; left main lesions of ≥ 50% were considered an indication for coronary bypass; single- or double-vessel disease was generally an indication for angioplasty, and triple-vessel CAD was usually considered an indication for CABG, particularly if left ventricular dysfunction was present, even with very low ejection fractions (≤ 20%). Because of the greater consensus and evidence of survival benefits, the final analyses focused on patients with triple-vessel or left main disease.

Data Analysis

Chi-square tests were used to analyze categorical variables and *t*-tests for continuous variables. Variables found to be statistically significant or likely to affect the recommendation for revascularization were assessed for collinearity by the Pearson's correlation matrix and Spearman's rank; none was found to be significant. The main outcome variable was a recommendation for revascularization (angioplasty or bypass surgery) compared with medical therapy. Variables significantly associated (in bivariate analyses) with decisions to recommend revascularization following coronary angiography were added to the multiple logistic regression models to assess the effect of race while controlling for potential cofounders. The primary multiple logistic regression analysis focused on only those patients with angiographically determined severe CAD (n = 194). Of these 194 patients, race/ethnicity was available on 94% (n = 182). In this model, race was trichotomized into Hispanic, black, and white to ascertain whether any differential effects of race/ethnicity existed while controlling for covariates associated with revascularization recommendations. Forward and backward stepwise logistic regression analyses were also used.

Results

Demographic and Clinical Characteristics

Table I represents the baseline characteristics, stratified by race (n = 797), of the patients who met inclusion criteria and had their first cardiac catheterization for the evaluation of ischemic heart disease. Of these 62% were white, 23% were Hispanics, 12.2% were African American, and 3% were other. The nonwhites were significantly younger, more likely to be females, have hypertension, diabetes, normal coronary arteries found on angiography, and more often given a recommendation for medical therapy (p = 0.006). Nonwhites were significantly less likely to have undergone exercise tolerance testing (ETT) prior to catheterization. This last finding remained significant when adjusted for patients found to have evidence of CAD (n = 590) at angiography (22% of nonwhites had ETT, compared with 31.9% of whites; p = 0.012). In whites and nonwhites (blacks and Hispanics) with moderate CAD (at least 50% stenosis of one or two vessels; n = 299), it was equally likely that revascularization was recommended (51.8 vs. 52.8; p = 0.88). There were no statistically significant differences in the left ventricular ejection fraction, priority, or indications for catheterization.

TABLE I Bsaseline characteristics of catheterization population according to race

	White (%) (n = 493)	Nonwhite (%) (n = 304)	p Value
Characteristics			
Mean age, years (SE)	61.3 (0.5)	57.7 (0.6)	0.000
Male	60.4	57.5	0.011
Risk factors			
Hypertension	47.5	59.8	0.003
Diabetes	20.3	34.5	< 0.001
PVD	11.3	12.8	0.53
ETT performed	36.1	25.3	0.002
Ejection fraction			
< 45%	22.2	21.2	
≥ 45%	77.8	78.5	0.76
Cath priority			
Elective	31.2	24.3	
Urgent	58.5	66	0.09
Emergent	10.3	9.67	
Indication for angiography			
Silent ischemia	8.5	7.9	
Chest pain	11.2	8.9	
Recent MI	31.9	36.8	0.46
Unstable angina	48.5	46.4	
Stenosis (> 50%)			
Single-/double-vessel	46.6	44.5	
Triple-vessel/left main	31.8	22.7	0.001
No stenosis	21.6	32.8	
Recommendations			
Medical	45.2	56.5	
PTCA/CABG	43.2	32.2	0.006
Either PTCA or CABG	11.4	11.3	

Abbreviations: SE = standard error, PVD = peripheral vascular disease, ETT = exercise tolerance test, MI = myocardial infarction, PTCA = percutaneous transluminal coronary angioplasty, CABG = coronary artery bypass graft.

TABLE II Characteristics of population with severe (i.e., left main or triple-vessel) coronary artery disease, according to race

Characteritics	White (%) (n = 135)	Nonwhite (%) (n = 59)	p Value
Mean age, years (SE)	65 (0.96)	64.5 (1.3)	0.74
Male	70	66	0.55
Risk factors			
Hypertension	53.7	71.2	0.023
Diabetes	27.4	52.5	0.001
PVD	12.1	24.1	0.036
ETT performed	32.1	27.6	0.54
Ejection fraction			
<45%	30.8	26.8	
≥45%	69.2	73.2	0.59
Cath priority			
Elective	28.0	22.0	
Urgent	61.4	67.8	0.66
Emergent	10.6	10.2	

Abbreviations as in Table I.

Bivariate Analyses for Patients with Severe Coronary Artery Disease

Table II represents clinical characteristics of patients (n = 194) with severe (left main or triple-vessel) stenoses. Nonwhites in this subset were also more likely to have hypertension, diabetes, as well as peripheral vascular disease (all p values < 0.05); however, there were no significant differences in mean age, the proportion who had undergone stress testing prior to angiography, or who had severe disease. Of all patients found to have clinically significant CAD (n = 590), 39.9% of whites had severe disease compared with 33.5% of nonwhites (p = 0.12). Table III shows the treatment recommendation post angiography, according to disease severity, race, and gender. In whites it was more likely than in nonwhites that revascularization (angioplasty or bypass surgery) was recommended (83.7 vs. 67.8%, p = 0.013). For patients with severe disease given a distinct recommendation for bypass surgery (n = 160), racial differences persisted: bypass surgery was recommended in 79.8% of whites compared with 62.8% of nonwhites (p = 0.021). There were no significant gender differences in the recommendation for revascularization.

Multivariate Analyses

The primary logistic regression model was trichotomized on race/ethnicity to ascertain whether any differential effects for treatment recommendations persisted after controlling for covariates among patients with severe disease who were given a distinct treatment recommendation, either for revascularization or for medical therapy (n = 182). Twelve patients (6%) were excluded from these analyses because they were given two treatment recommendations, that is, either revascularization or medical therapy. Among those with severe disease and a distinct treatment recommendation, after controlling for age, gender, ejection fraction, anginal status, diabetes, hypertension, and presence of peripheral vascular disease, being Hispanic was a significant predictor for not receiving a revascularization recommendation (see Table IV). Hispanics with severe disease were significantly less likely (p = 0.031) to receive a revascularization recommendation than did whites with severe disease [OR = 0.39; 95% CI (0.17, 0.92)]. Being Hispanic remained the strongest predictor in forward and backward logistic regression models as well. Blacks were 67% as likely as whites to receive a recommendation for revascularization; however, this did not reach statistical significance (p = 0.58). In the subset, in which complete data were available for variables used in the logistic regression equation for recommendations to CABG alone (147 or 92% of the 160 patients to whom bypass rather than medical therapy was recommended), a trend persisted for Hispanics (OR = 0.42; p = 0.06).

Medical Record Reviews

We were able to retrieve 35 of the 40 records for patients with severe CAD, for whom medical treatment was recommended, to ascertain the "actual treatment" received versus the

TABLE III Treatment recommendations for patients with severe disease, according to race and gender

	Race		Gender	
	White (W) (%)	Nonwhite (NW) (%)	Men (%)	Women (%)
Recommendation				
(n = 135 W, n = 59 NW)			(n = 138 M, n = 62 F)	
Medical therapy	16.3	32.2	79.7	75.8
[a] PTCA or CABG	83.7	67.8[b]	20.3	24.2
CABG (n = 109 W, n = 51 NW)			(n = 116 M, n = 49 F)	
	79.8	62.8[c]	75.9	69.4

[a] Represents revascularization (PTCA or CABG) compared with medical therapy.
[b] p Value = 0. 013.
[c] Represents CABG compared with medical therapy; p = 0.021.
Abbreviations as in Table I.

TABLE IV Multiple logistic regression for revascularization recommendations following angiography for patients with severe coronary artery disease (n = 180): Odds ratio (OR)[a]

Variable	OR	95% CI
Age	1.01	(0.98, 1.05)
Male	1.29	(0.58, 2.90)
Ejection fraction	0.66	(0.30, 1.44)
Anginal status	1.32	(0.62, 2.80)
Diabetes	0.57	(0.26, 1.26)
Hypertension	0.52	(0.22, 1.19)
PVD	1.42	(0.45, 4.48)
Black	0.67	(0.17, 2.71)
Hispanic	0.39	(0.17, 0.92)

[a] Variables in the multiple logistic regression model obtained by comparison of men with women; severely or moderately reduced (< 45%) compared with normal or slightly reduced ejection fraction (≥ 45%); unstable compared with stable angina; presence of diabetes, hypertension, or PVD, African American/blacks and Hispanics compared with whites. Age was treated as a continuous variable. Backward and forward logistic regression analyses were performed.
Abbreviations: CI = confidence interval, PVD = peripheral vascular disease.

"recommendation" for treatment previously analyzed above. Seven patients (three Hispanics, two whites, and two African Americans) were ultimately referred for revascularization (within 6 months) for the following precipitating events: one required PTCA for preoperative clearance, three had recurring angina on medications, two patients subsequently had an acute myocardial infarction, and one patient had CABG 3 years later. For patients whose initial recommendation did not change (n = 28), the chart review also revealed that two patients had refused revascularization and wanted to try medicine first, two were lost to follow-up, and nine had such severe or diffuse disease that revascularization did not appear to be an alternative. Of these nine patients, five were Hispanic and four were white.

Discussion

Many institutions have found differences in the delivery of cardiac care among different racial or ethnic groups.[5–7, 10, 11, 15–18] Among patients with the most severe CAD (left main or triple-vessel), we found that revascularization was less likely to have been recommended to nonwhites. Recent studies have documented that patients with triple-vessel or left main coronary disease have the most survival benefit from revascularization, and the decisions made from angiographic findings are of measurable clinical significance.[19–21] However, the findings from the medical records reviewed underscore the importance of ascertaining previously unreported clinical as well as the effect of nonclinical or extracardiac factors on coronary revascularization recommendations. As mentioned previously, clinical factors may have accounted for most of the observed differences since nine patients were deemed inoperable due to such diffuse or distal CAD, and nonclinical factors, such as patients' preferences for less aggressive therapy and loss to follow-up. Also, the presence of language or sociocultural barriers, knowledge of risks, and benefits of revascularization procedures, discussions with the patient/family or the referring physician, as well as the effect of psychosocial factors pertaining to these patients, might have impacted on the physicians' decision-making process. These factors could not be ascertained from the medical records reviewed.

A curious finding remains for patients with moderate CAD (50% stenosis of one or two vessels). One might anticipate gender and/or racial differences would be seen in this moderate disease category, because for this group of patients practice guidelines within medicine are less certain, whereas there is widespread consensus on the management of left main CAD and a similar level for the management of patients with triple-vessel disease.[21–26] When the moderate disease group was combined with patients with severe CAD, a trend persisted for whites compared with blacks and Hispanics to be referred to revascularization; however, this did reach conventional levels of statistical significance (OR = 1.36; 64.1 vs. 56.7%; p = 0.11). Plausible reasons for this finding include that there might be more discretion for the involved physicians for treatment recommendations among patients with moderate CAD, and many patients were much more involved in the decision-making process. Other unmeasured clinical as well as nonclinical factors also may have played a crucial role in the final treatment decisions made. These factors can be better studied prospectively. Moreover, this group of patients may be less likely to exemplify a distinct pattern upon which a single parameter or factor influencing treatment recommendation could be easily discerned. Patients with the most severe CAD for whom the benefits of revascularization are more clearly defined were selected to be examined, because this category could be anticipated to lead to a specific pattern of therapeutic recommendation from which a deviation could be ascertained.

The process by which the aforementioned treatment decisions were made could not be explored in depth. It is unclear whether the decisions were shared between the primary physicians and family members or just made between the angiographer and the patients' private physicians only. Not all these factors could be gleaned from the database used in this study or were contained in the medical records reviewed, but each could have contributed to the results and merits further investigation.

Limitations

Data were analyzed for the recommendation for therapy and not the actual treatment received by all patients, which may represent an unstable endpoint in the clinical database. However, as evidenced by the medical records reviewed for 35 of 40 patients given a recommendation for medical therapy, only 6 patients eventually had revascularization within 6 months and in all but 1 this was because of precipitating ischemic events; 2 patients opted for medical therapy instead of angioplasty.

The study sample was limited to patients already referred to angiography, thus subject to referral bias. Perhaps minimal differences in revascularization recommendations occur among patients followed prior to angiography. The authors have a project in progress that will prospectively examine referral rates to angiography and revascularization based on participants' medical clinic presentation and stress test results. However, it has been reported previously that gender and racial differences exist in the referral of patients to coronary angiography.[15,18]

The observed differences in treatment recommendations might have been influenced by other clinical factors, such as smoking status or diffuse CAD. However, when the former variable was added to the multiple logistic model, the results were unchanged. Moreover, more whites than blacks and Hispanics were smokers (34 vs. 25.4%; p = 0.23). Complete data were unavailable for the diffuseness of CAD; however, diabetes was used as a proxy for diffuse CAD.[24]

Financial information was not available on all patients; thus we were unable to control for insurance status. However, at the institution where the study was conducted, there is no financial incentive to the angiographers since all are salaried. Whittle *et al.* examined the rate of revascularization for patients in the United States Veterans Affairs Hospitals where financial incentives are also removed and found racial differences in the use of bypass surgery.[10] Moreover, review of the medical records of patients who received a medical recommendation did not reveal that financial matters were of concern. Seven of the 35 patients (20%) with severe CAD, who were originally recommended for medical therapy, underwent revascularization within 6 months due to acute coronary events. Two patients who refused to undergo revascularization although it was recommended cited personal reasons such as their desire for conservative or less aggressive treatment, not financial matters.

It is unlikely that observer or selection bias was present at the time of the study. This study was ongoing in the catheterization laboratory over a period of 3 years and was known only to the director of the laboratory. The forms used to collect the study data were incorporated in the standard catheterization forms as part of the general clinical information collected by staff for all patients admitted for cardiac catheterization. These forms were actually generated at the time that New York State was assessing its own angioplasty database; thus, it is unlikely that anything unusual in the design or content of the intake forms was noted by the angiographers/attending physicians, or housestaff. Currently, the forms continue to serve as the admitting catheterization document for the Division of Cardiology. Moreover, awareness of the study would most likely bias the results toward the null hypothesis.

Conclusions

This present study indicates that racial and ethnic differences in the use of the revascularization are manifested in the recommendations made after the catheterization and may be explained by previously unmeasured clinical as well as nonclinical factors. How these nonclinical or psychosocial factors may affect differential recommendations to coronary angiography and revascularization needs to be explored in depth and prospectively before such findings can be ascribed to racial/ethnic bias alone.

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