Referrals to High-Quality Cardiac Surgeons: Patients' Race and Characteristics of Their Physicians

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Objective. To examine the referral process to cardiac surgeons in order to explain racial disparities in access to high-quality cardiac surgeons.

Data Sources/Study Settings. All white and black Medicare fee-for-service patients undergoing coronary artery bypass graft (CABG) surgery in New York State during 1997–1999.

Study Design. A retrospective analysis of referral patterns for white and black patients in relation to the quality of the cardiac surgeon, measured by the surgeon's risk-adjusted mortality rate (RAMR), and in relation to characteristics of the physician providing the majority of cardiac care before the surgery. The average RAMRs of the surgeons to whom different physicians referred patients were compared using *t*-tests and paired *t*-tests. A hierarchical multivariate regression model was estimated to test hypotheses about the effect of physicians' characteristics on referrals of blacks to low-quality surgeons.

Data Extraction Method. Variables were constructed from Medicare claims.

Principal Findings. The differential in surgeons' quality for white and black patients is partially due to the physician providing the majority of cardiac care before the surgery. There is both across- and within-physician variation in referrals. Of the physician characteristics investigated, only the number of black patients referred to CABG and the percent of all cardiac referrals to the same hospital decrease the difference in surgeons' quality between whites and blacks.

Conclusions. Several different pathways lead blacks to cardiac surgeons of lower quality. Further research is needed to understand the causes and inform policies designed to minimize disparities in access to high-quality providers.

Key Words. Racial disparities, CABG, quality, referral to specialists, risk-adjusted mortality

Although much of the evidence regarding racial disparities in cardiac surgery care focuses on lack of access to services, that is, low utilization rates of coronary artery bypass graft (CABG) procedures by minorities (Canto et al. 2000;

Epstein et al. 2003; Kressin et al. 2004; Lillie-Blanton et al. 2004), recent studies have identified another dimension of disparity—minorities who do gain access to services are more likely to receive these services from low-quality providers. Blacks in New York State (NYS) have been shown to be more likely to be treated by cardiac surgeons with higher risk-adjusted mortality rates (RAMRs) (Mukamel, Murthy, and Weimer 2000). This suggests that the referral process that leads to the choice of a specific cardiac surgeon may be different for white and black patients.

Not much is known about the referral choice of a specific specialist from a pool of providers of the same specialty, and with two exceptions (Kinchin, Cooper, Levine et al. 2004; Kinchen, Cooper, Wang et al. 2004) all studies addressing this question are from the 1970s and 1980s. All suggest that the quality of the specialist, measured in various ways, is the most important factor (Ludke 1982). For example, both Kinchen, Cooper, Levine et al. (2004) and Javalgi et al. (1993) found that perceived medical skill was the most important factor determining choice of a specialist among a national sample of primary care physicians, with about 90 percent reporting this to be the most important factor. Shortell (1973) finds that internists are more likely to refer to specialists who are considered to have high status, where status is defined by leadership positions, publications and presentations, membership in professional organizations, and perceptions by other physicians as being influential. These studies also examined patient characteristics in relation to the referral choice, such as insurance coverage, location, and patient convenience (Ludke 1982; Ludke and Levitz 1983; Javalgi et al. 1993; Kinchen, Cooper, Levine et al. 2004). These factors are considered by referring physicians to be important but they are ranked lower than clinical quality. None of these studies, however, examined the role of the patient's race in these decisions, and thus cannot shed light on why blacks tend to be referred to lower quality cardiac surgeon compared with whites.

To gain an understanding of this facet of racial disparities, we performed an analysis of several aspects of the referral process to cardiac surgeons.

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A MODEL OF THE PROCESS LEADING TO CABG SURGERY

Figure 1 is a schematic of the process leading patients to CABG surgery. It identifies several nodes at which the choice of a cardiac surgeon could be made (identified in Fig. 1 by shaded ellipses). The figure shows that for those who have been diagnosed with heart disease before the surgery, the first choice-determining node (node 1) is a referral to a cardiologist. As many physicians have long-standing referral relationships, it is possible that the choice of a cardiologist

Figure 1: Referral to Cardiac Surgeon for Coronary Artery Bypass Graft (CABG) Surgery.

The shaded ovals represent decision nodes at which the choice of a cardiac surgeon or a subset of surgeons may be determined.

predetermines the referral to a specific cardiac surgeon (or to a small group of surgeons). The second choice-determining node (node 2) is at the time that the cardiologist refers the patient to a cardiac surgeon. Cardiologists may have a panel of surgeons among whom they choose. For example, they may perceive some surgeons as better at treating some type of patients than others (Rothenberg et al. 2004). Thus, the same cardiologist may refer patients to several different surgeons. A similar process may occur if the primary care physician refers to a cardiac surgeon directly (node 3). The fourth choice-determining node (node 4) occurs in the hospital for those patients who have not been diagnosed with heart disease before the admission-precipitating health event (e.g., an acute myocardial infarction). In these cases, especially if the patient is not under the regular care of a community physician, the evaluation and the decision of the need to operate will be made by the hospital cardiologist and the cardiac surgeon on call. The operating surgeon is then likely to be the surgeon on call. While not shown in Fig. 1, it is possible for the patient's physician to be involved in the choice even for those patients who were not diagnosed before the hospital admission, as often several days may pass between the admission and the surgery and there is time for patients to consult with their own physician. For these cases, decision node 3 may be more relevant.

This referral model suggests that an analysis designed to explain racial disparities in access to high-quality surgeons should examine the variations in referral patterns both across-referring physicians and within-referring physicians, and control for whether the surgery was performed on an emergency basis.

The choice of a specific cardiac surgeon is likely a joint decision between the patient and the referring physician. (The degree to which the decision is made mutually versus a decision dominated by either the physician or the patient is outside the scope of this study.) Thus, we would expect this choice to depend on characteristics of both the patient and the referring physician. We also note that for lack of a better term we use the word referral throughout the paper, recognizing that the referral decision could have been made by the physician, the patient, or both.

DATA AND VARIABLES

Sample

Patients. The study included 21,989 white and black NYS Medicare fee-for-service (FFS) enrollees (age 65 or older) who underwent CABG procedures

between 1997 and 1999. We included only FFS patients because they are not limited in their choice of surgeons, whereas those who are enrolled in restricted panel managed care organizations might be. Patients were identified from the Medicare inpatient claims as those with admissions for DRGs 106 and 107.

Cardiac Surgeons. The “accountable” surgeon was identified from the Medicare physician part B claim, as the surgeon who’s billing claim did not include CPT modifier codes indicating assistant status.

Physicians Who Provide the Majority of Cardiac Care before Surgery. To identify the physician who may have referred the patient to the cardiac surgeon, we followed the method we used previously (Mukamel et al. 2005) and identified the physician who provided the majority of cardiac care before the surgery. It is likely that this is the physician who refers the patient to surgery and participates in the choice of surgeon. Using Medicare physician part B claims, we analyzed patterns of visits to cardiologists and primary care physicians occurring during the 6 months preceding the surgery. We identified the physician based on the following decision rules: If the patient made visits to a single cardiologist, then that cardiologist is chosen as this physician. If the patient made visits to more than one cardiologist, then the one with the most visits is designated as this physician. If the patient made equal numbers of visits to more than one cardiologist, then the most recent is selected. If there were no visits to cardiologists, then the analysis is repeated for primary care physicians (internal medicine, family medicine, or general practice). We compared the percent of surgeries that had an identified physician based on analyses of data for 1–6 months before the surgery in 1-month increments. The majority of physicians (91.5 percent) were identified within a 2 month window of the surgery. Therefore, in the final analysis, we define these physicians based on the 2 months before surgery.

We note that this method may not always identify the referring physician. In particular, when the surgery is performed as an emergency, it is possible that cardiologists seeing the patient in the hospital or the cardiologists performing tests would be the ones to make referral suggestions. However, even for emergency surgery there is often time for the patients, or more likely their families, to consult with their regular physician, either a cardiologist or a primary care physician if the patient was not under the care of a cardiologist. Preliminary results from a current survey of CABG patients in

NYS suggest that these instances are infrequent. Of 25 CABG patients, the majority (22) reported that either their cardiologist or their primary care physician were the ones to make referral suggestions. Recognizing the possibility that we misidentify the physician involved in the referral decision for emergency surgery, we repeated the analysis for all nonemergency cases. The results are similar to those for the whole sample and we therefore report the results for the whole sample.

Variables

Surgeons' Quality. The quality of cardiac surgeons was measured by their RAMRs, which are reported in the 2002 NYS Coronary Artery Bypass Surgery Report (New York State Department of Health 2002). These RAMRs were calculated by NYS based on data for the period 1997–1999 as follows: The state average mortality rate is multiplied by the ratio of the surgeon's observed mortality rate to the surgeon's predicted rate. The predicted rate controls for the risk factors of the patients treated by the surgeon: age, gender, hemodynamic state, comorbidities, severity of the arteriosclerotic process, ventricular function, and previous open-heart operations (New York State Department of Health 2002). It is calculated as the average of predicted mortality probabilities of all patients treated by the surgeon. The predicted probabilities for patients are estimated by NYS using logistic regression models.

The RAMRs published by NYS are considered to be among the most credible quality measures reported. They are based on clinical risk factors specific to CABG surgery, rather than administrative data, which are more limited. They have been extensively studied and validated (Hannan et al. 1990) and have been linked to reductions in CABG mortality in NYS (Hannan et al. 1994; Peterson et al. 1998). They have been judged by the health care market to be providing valid information about quality as attested to by their influence on referral decisions of FFS Medicare patients (Mukamel et al. 2005) and contracting decisions by managed care organizations (Mukamel, Mushlin et al. 2000; Mukamel et al. 2002).

Patient Characteristics. The Medicare claims files provide information about the patient's age, gender, race, diagnoses, and procedures. They also indicate if the surgery was an emergency. We augmented these data with information about the median income and percent high school graduates in the zip code of patient residence (stratified by race and age). These serve as proxies for the

patient's income and education level. Because our prior study (Mukamel et al. 2005) shows that patients who seek a second opinion before the surgery are also more sensitive to the quality of the surgeon, we included an indicator variable for second opinion. This variable was calculated from the claims data and obtained the value 1 if the patient saw another cardiac surgeon in the 2 months before the surgery, 0 otherwise. Distance has also been shown to be an important determinant of choice (Luft et al. 1990; Rothenberg et al. 2004). To capture potential tradeoffs between quality and distance, we constructed a variable measuring the difference in distance between the patient residence and the surgery hospital and the patient residence and the closest alternative CABG hospital.

Characteristics of the Physician Providing the Majority of Cardiac Care before the Surgery. For each physician, we identified his or her panel of surgeons as all surgeons treating CABG patients seen by this physician. To measure the quality of the surgeons to which each physician refers we calculated the average RAMR of each panel of surgeons weighted by the number of patients referred to each surgeon. We also calculated for each physician the average RAMR for two subpanels—the panel treating the physician's black patients and the panel treating the physician's white patients.

Physicians' age and specialty were obtained from the Medicare Physician Registry and Eligibility Registry file. Variables characterizing the practice of the physician were created from the inpatient, outpatient, and physician part B claims and were based on all cardiac patients seen by the physician. Cardiac patients were defined as Medicare beneficiaries having CABG, angioplasty, angiography, or cardiac catheterization. These variables included the number of all patients that the physician referred to CABG, the number of blacks the physician referred to CABG, the percent of cardiac patients the physician referred to the same hospital, and four variables measuring the severity of the CABG patients referred by the physician—their average age, percent female, the average number of grafts, and the percent of surgeries performed as an emergency. The rationale for including these variables in the analysis is that they may influence the physician's knowledge of the quality of cardiac surgeons or the physician's referral patterns. For example, physicians who make many referrals for CABG surgery are expected to be better informed about the quality of surgeons because they face both a higher return to investment in learning about the quality of surgeons and lower costs of learning because they observe the experience of many patients. Similarly, physicians who refer higher risk patients to surgery

(i.e., older, female, and with more grafts) may have a stronger incentive to learn the quality of the surgeons.

ANALYSES

We performed several analyses. The first analysis was designed to determine if the physician contributes to the differential in surgeons' RAMR between black and white patients. We present a series of linear regression models in which the dependent variable is the surgeon's RAMR. The first model includes only race as an independent variable. We then add sequentially different categories of explanatory variables, to examine whether the race differential in the RAMR declines as these variables enter the model. If introduction of other variables lowers the race effect estimated in the initial model then we can conclude that the differential depends on these factors, and that race serves as a proxy for these factors when they are excluded from the model. Physicians are added to the model last to determine if they contribute to the race effect even after one controls for individual and regional characteristics. Because of the clustering of the data by referring physician, only the last model including fixed effects for physicians should be viewed as a fully specified model. Palta and Seplaki (2002) note that even such a fixed-effect specification may involve bias in estimation of the treatment effect, in this case race, when the treatment is not randomly assigned within clustering units. Localio, Berlin, and Ten Have (2002) report simulation results that suggest bias in fixed-effect estimation is generally small relative to random effect models that assume independence of random effects and errors due to excluded variables, especially when the number of cases per clustering unit is large. With these cautions, the results of the first analysis should be viewed primarily in terms of determining whether the referring physician accounts for a major portion of racial difference in RAMR. As these models are very similar to models we published before (Mukamel, Murthy, and Weimer 2000; Rothenberg et al. 2004) we present here only the changes in the race coefficient.

The second analysis focused on the variation across physicians in the quality of the surgeons to whom they refer their CABG patients. Of the 3,094 physicians that we identified, only 529 referred any black patients to CABG. We compared the average panel RAMR for these two groups of physicians: those with at least one black patient referred to CABG and those without any black CABG patients. This analysis was performed at the physician level. A *t*-test was used to determine if the panel RAMR was significantly different for

the two groups. This analysis answers the question of whether black patients receive the majority of their cardiac care before the surgery from physicians who have referral networks of lower quality—i.e., the across-physician variation.

The third analysis addressed the within physician variation. The sample for this analysis was limited to the physicians who referred at least one black to CABG, and it included all their CABG referrals. We first present the average panel RAMR for the black referrals and the average panel RAMR for white referrals and test for the difference between them using paired *t*-tests. We then present a multivariate analysis that examines the effect of physician characteristics. We estimated a hierarchical model using *HLM* version 5 (SSI International) software in which the unit of analysis is the individual patient (level 1) and patients are clustered within physicians (level 2). The dependent variable is the surgeons' RAMR minus the average RAMR for surgeons in the same market (geographic region), and the independent variables include the physician average referral RAMR, other characteristics of the physician- and patient-level variables. The model assumed both a random intercept and a random coefficient for the variable indicating that the patient is black. To examine the influence of the characteristics of physicians (level 2) on the differential referral of blacks, we modeled the coefficient on the black indicator variable (level 1) as a random draw from a distribution with a mean determined by the physician characteristics (level 2). The model was estimated allowing for heteroskedastic errors based on race, on whether the patient sought second opinion, and on whether the procedure was carried out on an emergency basis. Statistical significance was inferred based on robust standard errors.

RESULTS

Table 1 shows descriptive statistics for the sample. Of the 21,989 CABG patients, 1,041 (4.7 percent) were black. The majority (65.5 percent) were male with average age of 73.3. Of all surgeries, 35 percent were emergency and 31 percent of patients sought a second opinion. The average difference in distance between the patient residence and the patient's CABG hospital and the closest CABG hospital was about 3 miles.

Of the 3,094 physicians, 57 percent were cardiologists. The average panel RAMR was 2.22 percent and it varied substantially across physicians with a coefficient of variation of 45 percent (standard deviation of 0.99

Table 1: Descriptive Statistics

	Mean	Standard Deviation (Shown for Continuous Variables)
Patient level variable, (N = 21,989)		
Age (years)	73.3	7.15
Male (%)	65.5	—
Black (%)	4.7	—
Diabetes (%)	29.8	—
AMI (%)	23.6	—
COPD (%)	12.0	—
Renal failure (%)	2.6	—
Chronic renal failure (%)	2.5	—
Ischemic stroke (%)	1.1	—
Shock (%)	0.1	—
Cardiac shock (%)	1.0	—
Race/zip-specific median income (1,000s dollars)	50.389	20.330
Race/gender/zip-specific percent of high school graduates	84.4	8.05
Emergency surgery (%)	34.9	—
Urgent surgery (%)	22.7	—
Scheduled surgery (%)	42.4	—
Patient sought second opinion (%)	31.2	—
Difference between distance from patient residence and CABG hospital and distance between patient residence and the closet CABG hospital (miles)	2.96	19.3
Referring physician level variables, (N = 3,094)		
Panel average RAMR (%)	2.22	0.99
Specialty		
Internist (%)	32.6	—
General practice (%)	2.5	—
Cardiology (%)	57.2	—
Family practice (%)	7.7	—
Physician age (years)	48.7	10.6
Average characteristics of CABG patients referred by the physician		
Number of CABG referrals	6.8	14.0
Number of blacks referred to CABG	0.29	0.88
Percent of cardiac patients referred to same hospital	62.6	30.1
Average age of CABG patients	73.5	5.4
Percent females among CABG patients	48.3	11.8
Average number of grafts	3.14	.82
Percent CABGs performed as emergency	46.4	41.2

AMI, acute myocardial infarction; COPD, chronic obstructive pulmonary disease; RAMR, risk-adjusted mortality rate; CABG, coronary artery bypass graft.

percent). The characteristics of the patients referred to CABG also varied substantially with coefficients of variations around 50 percent.

Table 2: Factors Contributing to Racial Differences in Surgeons RAMRs

	<i>Excess Percent of RAMR: Blacks Relative to Whites (SEs)</i>
Model 1 ($n = 22,867$; $R^2 = 0.01$) RAMR as a function of race	0.57** (0.050)
Model 2 ($n = 22,867$; $R^2 = 0.01$) Model 1 plus heteroskedasticity correction	0.39** (0.034)
Model 3 ($n = 22,867$; $R^2 = 0.01$) Model 2 plus year fixed effects	0.39** (0.035)
Model 4 ($n = 22,867$; $R^2 = 0.02$) Model 3 plus gender, sex, clinical covariates, and second opinion	0.33** (0.035)
Model 5 ($n = 22,759$; $R^2 = 0.04$) Model 4 plus socio-economic covariates	0.22** (0.037)
Model 6 ($n = 22,759$; $R^2 = 0.18$) Model 5 plus regional fixed effects	0.17** (0.034)
Model 7 ($n = 22,571$; $R^2 = 0.46$) Model 6 plus physician fixed effects	0.10** (0.038)

** $p \leq 0.01$;* $0.01 < p \leq 0.05$.

RAMR, risk-adjusted mortality rate; SE, standard error.

Factors Contributing to Racial Differences in Surgeons' RAMR

Table 2 reports the changes in the coefficients for black race in a model predicting the surgeon's RAMR. When only a variable indicating race is included in the model, the difference in surgeon RAMR between white and black patients is 0.57 percentage points ($p < .01$). This is about 25 percent of the 2.24 percent state average mortality rate. When we correct for the heteroskedasticity due to the differences in the accuracy of the surgeons' RAMRs (which depend on the sample used to calculate the RAMR and which differs by surgeon), the differential declines substantially to 0.39 percentage points. Adding clinical risk factors and sociodemographics result in a further decline in the RAMR differential between blacks and whites to 0.22 percentage points. Regional variation diminishes the differential further to 0.17 percentage points. The last model adds fixed effects for the physicians providing most of the cardiac care before surgery. The differential between whites and blacks declines to 0.10 percentage points but remains significant at the .01 level. This decline leads us to conclude that these physicians do play a role in the disparities in access to high quality surgeons. The remaining significant race effect indicates that there is statistical significance within physician variation even after controlling for the variety of patient characteristics included in the model.

This analysis suggests that the physicians providing most of the cardiac care before surgery may contribute up to 30 percent to the initial racial disparity effect of 0.57 (0.17 of 0.57), which is equivalent to 8 percent lower quality relative to the state average, when quality is measured by the RAMR.

Table 3: Referring Physician Panel Average RAMR*

<i>(I) All Referring Physicians—Across Physician Variation</i>				
<i>Referring Physicians with Black CABG Patients</i>		<i>Referring Physicians without Black CABG Patients</i>		
<i>No. of Referring Physicians</i>	<i>Average Panel RAMR % (1)</i>	<i>No. of Referring Physicians</i>	<i>Average Panel RAMR % (2)</i>	<i>Difference in RAMR %: (1)–(2) (p-Value in Parentheses)</i>
529	2.42	2,565	2.19	0.23 ($p < .000$)
<i>(II) Referring Physicians with at Least One Black CABG Patient—within Physician Variation</i>				
<i>Mean Panel RAMR for Black Patients (%) (1)</i>		<i>Mean Panel RAMR for White Patients (%) (2)</i>		<i>Difference in RAMR (%): (1)–(2) (p-Value in Parentheses)</i>
2.44		2.28		0.16 ($p = .011$)

*The referring physician surgeon panel is defined as all cardiac surgeons who provided CABG surgery to patients referred by this physician. The panel average RAMR is the average RAMR of all the surgeons included in the referring physician panel.

RAMR, risk-adjusted mortality rate; CABG, coronary artery bypass graft.

Across- and Within-Physician Variations

Table 3 (part I) shows the average panel RAMR for physicians who have at least one black patient and those who have no black patients. The average for the first group is 2.42 percent and for the latter 2.19 percent. The difference of 0.23 percentage points is significantly different from zero ($p < .000$) and is about 10 percent of the state average RAMR.

Table 3 (part II) reports the panel RAMR calculated separately for black and white patients seen by the same physician. The average panel RAMR for the black patients is 2.44 and 2.28 percent for the white patients. The difference of 0.16 percentage points is significantly different from zero ($p = .011$) and is about 7 percent of the state average RAMR.

These results indicate that referrals of blacks to lower quality cardiac surgeons are partly due to their access to different physicians and partly due to differential referrals of patients seen by the same physician. The magnitude of the differences suggests that on average blacks receive care from surgeons who are at around 10 percent below the state average.

Physician Characteristics Contributing to the Within-Physician Variation

Table 4 presents the results of the multivariate analysis using a hierarchical linear model with random intercept and random coefficient for race. The

Table 4: Hierarchical Model Predicting Referral RAMR

<i>Variables</i>		
<i>Patient Level</i> <i>N = 7,404 (Level 1)</i>		
Intercept		
Race = black		
<i>Referring Physician</i> <i>Level N = 529 (Level 2)</i>		
Intercept		
Referring physician panel RAMR		
Intercept		
<i>Referring physician characteristics specialty</i>		
Internist		
General practitioner		
Cardiologist		
Family practice		
Physician age in 10 years		
Average age of CABG referrals		
Percent of CABG referral performed as emergency		
Average number of grafts per referred patient		
Percent of referred patients that are female		
Number of patients referred to CABG ($\times 10$)		
Percent of CABG referrals to same hospital		
Number of black patients referred to CABG		
(Number of black patients referred to CABG) squared		
Emergency surgery		
Urgent surgery		
Patient sought second opinion		
Patient clinical risks		
Age		
Male		
Diabetes		
	<i>Coefficient</i>	<i>P-Value</i>
	- 1.27	.000
	0.72	.000
	0.37	.652
	Reference	
	category	
	- 0.11	.462
	0.14	.287
	- 0.01	.969
	- 0.04	.309
	0.00	.993
	- 0.16	.183
	0.06	.363
	0.04	.909
	0.02	.002
	- 0.42	.006
	- 0.18	.001
	0.02	.007
	0.03	.410
	0.13	.006
	- 0.02	.678
	- 0.003	.044
	- 0.00	.917
	0.02	.489

AMI	– 0.03	.250
COPD	– 0.05	.197
Renal failure	0.05	.509
Chronic renal failure	– 0.01	.909
Ischemic stroke	0.11	.374
Shock	0.69	.231
Cardiac shock	0.36	.030
Patient socio-economic status:		
Race/zip-specific median income (in \$10,000)	0.02	.059
Race/gender/zip-specific percent of high school graduates	– 0.21	.399
Difference in distance between the CABG hospital and the closest CABG hospital	– 0.00	.637

AMI, acute myocardial infarction; COPD, chronic obstructive pulmonary disease; RAMR, risk-adjusted mortality rate; CABG, coronary artery bypass graft.

variance component for both was significant at the 0.01 level indicating the appropriateness of treating these coefficients as random. Note that the sample for this analysis included only those 7,404 patients who were seen by the 529 physicians who had at least one black CABG patient. Table 4 reports both the coefficients for the individual patient-level variables (level 1) and coefficients for the referring physician-level variables (level 2).

In this sample, most of the individual patient characteristics were not significantly associated with the surgeon's quality with three exceptions. Those patients that had an urgent surgery were treated by surgeons with a higher RAMR (by 0.13 percentage points, $p = .006$) compared with both scheduled and emergency surgery patients. The lower quality relative to those with scheduled surgery may be due to the fact that those with scheduled surgery have more time to shop for the best surgeon. The lower quality relative to those requiring emergency surgery may be because emergency surgeries are likely considered higher risk and therefore efforts may be made to direct them to the better and more experienced surgeons. A similar phenomenon may explain why older patients are also likely to be operated on by better surgeons with lower RAMR ($p = .044$). Interestingly though, none of the other comorbidities, except cardiac shock, were associated with access to better surgeons and patients in cardiac shock were actually more likely to be treated by lower quality surgeons with a higher RAMR ($p = .030$).

The physician characteristics were entered into the model as modifiers of the coefficient for blacks. This coefficient measures the differential in the RAMR of surgeons for white and black patients. We find that the age and specialty of the physician do not significantly affect this differential. Similarly, physicians who tend to refer riskier patients, i.e., more females, older patients, and those requiring more grafts, exhibit the same differential in referrals between their white and black patients. Three characteristics of the physician practice do exhibit significant effects. The smallest effect and the only positive one—i.e., increasing the RAMR—is for black patients referred by physicians who refer more patients to CABG surgery. Blacks seen by a physician who refers one more person to CABG have a higher RAMR of 0.002 percentage points. Although statistically significant, this effect is very small. On the other hand, blacks referred by physicians who refer more black patients are referred to better surgeons and the effect is much larger—ranging from a 0.16 to 0.40 percentage points decrease in the RAMR per additional black CABG patient referred.¹ This translates to an effect ranging from 7 to 18 percent of the state average. Another important factor is if blacks are referred to surgeons practicing in a hospital to which the physician refers many of his or her cardiac

patients. An increase of 1 percentage point in the percent of referrals the physician makes to the same hospital lowers the surgeon's RAMR by 0.42 percentage points, or 19 percent of the state average.

Race, second opinion, emergency status, and urgent status all were statistically related to the level 1 variance. The race effect was particularly strong. The estimated variance for nonemergency and nonurgent patients who did not seek a second opinion was 0.75 for whites and 1.43 for blacks. (The estimated variance for non-urgent and non-emergency patients seeking a second opinion was 0.58 for whites and 1.11 for blacks.) Level 1 patient characteristics thus explain a lower percentage of variation in surgeon RAMR for blacks than for whites. Assuming patients are risk averse, this higher variance indicates that blacks do worse in the referral process not only because of the mean differences in quality but because they face more uncertainty in getting to good surgeons.

DISCUSSION

This research examines factors contributing to the disparity in access to high-quality cardiac surgeons that blacks face in NYS. The analysis demonstrates that the physician providing most of the cardiac care before surgery may contribute up to 30 percent to the differential in the quality of surgeons treating blacks and whites, after controlling for patient clinical and socio-economic characteristics. It further shows that the process involving this physician contributes in two ways. First, blacks are accessing a subset of all physicians, and this group of physicians is associated with a subset of the surgeons, a subset that has higher RAMR. Second, white and black patients seen by the same physician are referred to different surgeons. The latter effect diminishes if the physician refers more blacks to CABG surgery or if the surgery is performed in a hospital to which the physician directs most of his or her business.

With the data available to us we cannot determine if the referral decision was made by the physician or the patient. It is possible that physicians offer their white and black patients the same panel of surgeons but that black patients choose those who have higher RAMR because of other characteristics that are of more importance to them—e.g., distance.

A tradeoff between surgeon quality and other attributes is a legitimate aspect of the choice as long as it is made by a fully informed patient. The question is whether blacks are indeed fully informed when they make the decision, or whether race affects the interaction between the patient and the physician,

and in some ways impedes the full transfer of information when the patient is black. Johnson et al. (2004) found that there are differences in the interaction between patients and their physicians. When the patient was black, the interaction was less patient-centered and more dominated by the physician, and physicians exhibited a lower level of positive affect. Therefore, it is possible that blacks do not receive the same information about their referral choice as do white patients. If they are not informed about the surgeon's RAMR or do not understand the information, then they may give it less weight than whites, and thus end up making choices that are skewed away from the best surgeons.

The finding that the within-physician disparity decreases with the number of black patients referred to CABG might be an indication that those physicians who deal with more black patients have learned how to impart information better to their black patients, and thus their patients are making choices that are more similar to those made by whites. It may also be the result of patient selection. Blacks may prefer physicians who would refer them to better surgeons. Thus, at the time they choose a cardiologist (node 1 in Fig. 1) they choose a physician who is more likely to refer them to a better surgeon. It is unclear how likely this latter process is, as it is questionable whether patients have information about the referral patterns by race of the various cardiologists available to them.

Our data also do not include information about the race of the physician, yet this may explain the higher RAMR for the panels of physicians referring blacks compared with those referring only white patients (the across-physician variation). Hargraves, Stoddard, and Trude (2001) found, based on the Community Tracking Study Physician Survey, that more minority physicians report having difficulty getting medically necessary referrals to high-quality specialists for their patients and have more difficulty admitting them to a hospital. Moy and Bartman (1995) report based on the 1987 national Medical Expenditures Panel Survey, that minorities are four times more likely than whites to identify a minority physician as their usual source of care. If these patterns hold for our cohort, i.e., if the majority of blacks in our study have black physicians, physicians who face difficulty referring to high-quality specialists, then it would explain our finding of higher RAMR for their panels.

Such patterns may also explain our finding that blacks are referred to higher quality surgeons if they are cared for in the hospital to which the physician refers most of her or his cardiac patients. The physician is likely to have more clout in a hospital to which he or she makes many referrals, clout that can be translated into being able to refer patients to the best surgeons. Furthermore, if the physician refers many patients to the same hospital, then

the physician is more likely to know the surgeons and their performance and thus is better able to make a referral based on the surgeon's quality.

To summarize, we find that several pathways, which depend on the physician the patient saw before surgery, lead blacks to the lower quality cardiac surgeons. Further research is required to determine whether the hypotheses we offer to explain these pathways do indeed contribute to the differences in referrals for blacks. Such information would help guide specific policies that could ameliorate these disparities. One policy that might effectively address all of these pathways is to publish a report card on referral patterns. Whether the reasons for differences in referrals are due to interaction between physicians and their patients, physicians and the surgeons and the hospitals, or the initial choice of cardiologist, increasing awareness of the existence of differences in referral patterns may influence the behavior of all involved.

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NOTE

1. These numbers are calculated from the regression coefficients for the number of blacks and number of blacks squared over the range of actual numbers of blacks.

REFERENCES

- Canto, J. G., J. J. Allison, C. I. Kiefe, C. Fincher, R. Farmer, P. Sekar, S. Person, and N. W. Weissman. 2000. "Relation of Race and Sex to the Use of Reperfusion Therapy in Medicare Beneficiaries with Acute Myocardial Infarction." *New England Journal of Medicine* 342 (15): 1094–100.
- Epstein, A. M., J. S. Weissman, E. C. Schneider, C. Gatsonis, L. L. Leape, and R. N. Piana. 2003. "Race and Gender Disparities in Rates of Cardiac Revasculariza-

- tion: Do They Reflect Appropriate Use of Procedures or Problems in Quality of Care?" *Medical Care* 41 (11): 1240-55.
- Hannan, E. L., H. Jr. Kilburn, M. Racz, E. Shields, and M. R. Chassin. 1994. "Improving the Outcomes of Coronary Artery Bypass Surgery in New York State." *Journal of the American Medical Association* 271 (10): 761-6.
- Hannan, E. L., J. F. O'Donnell, G. Lukacik, and E. S. Shields. 1990. "Adult Open Heart Surgery in New York State: An Analysis of Risk Factors and Hospital Mortality Rates." *Journal of the American Medical Association* 264 (21): 2768-74.
- Hargraves, J. L., J. J. Stoddard, and S. Trude. 2001. "Minority Physicians' Experiences Obtaining Referrals to Specialists and Hospital Admissions." *Medscape General Medicine* 3 (4): 10.
- Javalgi, R., W. B. Joseph, W. R. Gombeski Jr., and J. A. Lester. 1993. "How Physicians Make Referrals." *Journal of Health Care Marketing* 13 (2): 6-17.
- Johnson, R. L., D. Roter, N. R. Powe, and L. A. Cooper. 2004. "Patient Race/Ethnicity and Quality of Patient-Physician Communication during Medical Visits." *American Journal of Public Health* 94 (12): 2084-90.
- Kinchen, K. S., L. A. Cooper, D. Levine, N. Y. Wang, and N. R. Powe. 2004. "Referral of Patients to Specialists: Factors Affecting Choice of Specialist by Primary Care Physicians." *Annals of Family Medicine* 2 (3): 245-52.
- Kinchen, K. S., L. A. Cooper, N. Y. Wang, D. Levine, and N. R. Powe. 2004. "The Impact of International Medical Graduate Status on Primary Care Physicians' Choice of Specialist." *Medical Care* 42: 747-55.
- Kressin, N. R., B. H. Chang, J. Whittle, E. D. Peterson, J. A. Clark, A. K. Rosen, M. Orner, T. C. Collins, L. G. Alley, and L. A. Petersen. 2004. "Racial Differences in Cardiac Catheterization as a Function of Patients' Beliefs." *American Journal of Public Health* 94 (12): 2091-7.
- Lillie-Blanton, M., T. M. Maddox, O. Rushing, and G. A. Mensah. 2004. "Disparities in Cardiac Care: Rising to the Challenge of Healthy People 2010." *Journal of the American College of Cardiology* 44 (3): 503-8.
- Localio, A. R., J. A. Berlin, and T. R. Ten Have. 2002. "Confounding Due to Cluster in Multicenter Studies—Causes and Cures." *Health Services and Outcomes Research Methodology* 3 (3-4): 195-210.
- Ludke, R. L. 1982. "An Examination of the Factors That Influence Patient Referral Decisions." *Medical Care* 20 (8): 782-96.
- Ludke, R. L., and G. S. Levitz. 1983. "Referring Physicians: The Forgotten Market." *Health Care Management Review* 8 (4): 13-22.
- Luft, H. S., D. W. Garnick, D. H. Mark, and D. J. Peltzman. 1990. "Does Quality Influence Choice of Hospital?" *Journal of the American Medical Association* 263 (21): 2899-906.
- Moy, E., and B. A. Bartman. 1995. "Physician Race and Care of Minority and Medically Indigent Patients." *Journal of the American Medical Association* 273 (19): 1515-20.
- Mukamel, D. B., A. S. Murthy, and D. L. Weimer. 2000. "Racial Differences in Access to High Quality Cardiac Surgeons." *American Journal of Public Health* 90 (11): 1774-7.

- Mukamel, D. B., A. I. Mushlin, D. L. Weimer, J. Zwanziger, T. Parker, and I. Indridason. 2000. "Do Quality Report Cards Play a Role in HMOs Contracting Practices?—Evidence from New York State." *Health Services Research* 35 (1, part 2): 319–32.
- Mukamel, D. B., D. L. Weimer, J. Zwanziger, S. Huang-Gorthy, and A. I. Mushlin. 2005. "Quality Report Cards, Selection of Cardiac Surgeons and Racial Disparities: A Study of the Publication of the NYS Cardiac Surgery Reports." *Inquiry* 41 (4): 1040–55.
- Mukamel, D. B., D. L. Weimer, J. Zwanziger, and A. I. Mushlin. 2002. "Quality of Cardiac Surgeons and Managed Care Contracting Practices." *Health Services Research* 37 (5): 1129–44.
- New York State Department of Health. 2002. "Coronary Artery Bypass Surgery in New York State." Available at <http://www.health.state.ny.us/nysdoh/consumer/heart/homehear.htm#coronary>
- Palta, M., and C. Seplaki. 2002. "Causes, Problems and Benefits of Different between and within Effects." *Health Services Research and Outcomes Research Methodology* 3 (3–4): 177–93.
- Peterson, E. D., E. R. DeLong, J. G. Jollis, L. H. Muhlbaier, and D. B. Mark. 1998. "The Effects of New York's Bypass Surgery Provider Profiling on Access to Care and Patient Outcomes in the Elderly." *Journal of the American College of Cardiology* 32 (4): 993–9.
- Rothenberg, B., T. Pearson, J. Zwanziger, and D. B. Mukamel. 2004. "Explaining Disparities in Access to High Quality Cardiac Surgeons." *Annals of Thoracic Surgery* 78 (1): 18–24.
- Shortell, S. M. 1973. "Patterns of Referral among Internists in Private Practice: A Social Exchange Model." *Journal of Health and Social Behavior* 14 (4): 335–48.