Understanding Racial Variation in the Use of Coronary Revascularization Procedures

The Role of Clinical Factors

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Background: Black patients undergo coronary artery bypass grafting and percutaneous transluminal coronary angioplasty less often than white patients. It is unclear how racial differences in clinical factors contribute to this variation.

Methods: A retrospective cohort study was performed of 666 male patients (326 blacks and 340 whites), admitted to 1 of 6 Veterans Affairs hospitals from October 1, 1989, to September 30, 1995, with acute myocardial infarction or unstable angina who underwent cardiac catheterization. The primary comparison was whether racial differences in percutaneous transluminal coronary angioplasty and coronary artery bypass grafting rates persisted after stratifying by clinical appropriateness of the procedure, measured by the appropriateness scale developed by the RAND Corporation, Santa Monica, Calif.

Results: Whites more often than blacks underwent a revascularization procedure (47% vs 28%). There was substantial variation in black-white odds ratios within different appropriateness categories. Blacks were significantly less likely to undergo percutaneous transluminal coronary angioplasty (odds ratio, 0.30; 95% confidence interval, 0.14-0.63 [P<.01]) when the indication was rated “equivocal.” Similarly, blacks were less likely to undergo coronary artery bypass grafting (odds ratio, 0.44; 95% confidence interval, 0.23-0.86 [P<.01]) when only coronary artery bypass grafting was indicated as “appropriate and necessary.” Differences in comorbidity or use of cigarettes or alcohol did not explain these variations. Using administrative data from the Veterans Health Administration, we found no differences in 1-year (5.2% vs 7.4%) and 5-year (23.3% vs 26.2%) mortality for blacks vs whites.

Conclusion: Among patients with acute myocardial infarction or unstable angina, variation in clinical factors using RAND appropriateness criteria for procedures explained some, but not all, racial differences in coronary revascularization use.

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PATIENTS AND METHODS

PATIENT SELECTION

Patients were selected from 6 Department of Veterans Affairs medical centers (VAMCs) representing the 4 original VA administrative regions (Northeast, Midwest, Southeast, and West) as they were defined in 1995. Study sites included the Birmingham VAMC, Birmingham, Ala; Milwaukee VAMC, Milwaukee, Wis; New York VAMC, New York, NY; Philadelphia VAMC, Philadelphia, Pa; Pittsburgh VAMC, Pittsburgh, Pa; and West Los Angeles VAMC, Los Angeles, Calif. Throughout the study, each site had the capacity to perform CABG on site or at an adjacent university hospital. The sites also varied in the proportion of patients who were black and in the frequency of CABG and PTCA performed among patients with potentially eligible admissions, indicating a spectrum of practice patterns. We identified potentially eligible patients using the Veterans Health Administration Patient Treatment File, a national administrative database containing data for all patients discharged from VAMCs. The Patient Treatment File includes abstracted discharge data, such as patient demographics and International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis and procedure codes. We identified all black and white men, aged 30 years or older, who underwent a left heart catheterization (ICD-9-CM codes 37.22-37.23 or 38.5-38.57) during an admission for an acute MI (ICD-9-CM codes 410-410.92) or unstable angina (ICD-9-CM codes 411.1-411.89). Patients were admitted between October 1, 1989, and September 30, 1995. We blocked potential subjects by 5-year age group, VAMC, primary diagnosis (acute MI or unstable angina), and year of discharge (in 2-year groups). We selected all black patients in each block, then randomly selected an equal number of white patients from that block. We excluded patients who had undergone PTCA during the year preceding the qualifying hospitalization, those who had undergone previous CABG, and those who were admitted for a medical illness other than ischemic heart disease and developed ischemia while in the hospital. We used administrative data from the Veterans Health Administration (the Beneficiary Identification and Record Locator Subsystem) to determine vital status as of December 31, 1996. This was matched previously against the Medicare Health Insurance Skeletonized Writeoff File and found to be 98% concordant for mortality.24

DATA COLLECTION

Each participating hospital’s institutional review board approved the study. Patient consent was not required because the study used blinded medical record review. We provided each site with a list of selected patients. Study personnel at each VAMC retrieved eligible medical records, photocopied them, and then placed a unique study identifier on each page of the copy. They then removed all references to the patient’s name, social security number, and race before sending the blinded copy to the coordinating center in Pittsburgh.

A board-certified internist (D.S.M.) reviewed each record to confirm that the clinical criteria for acute MI or unstable angina were present. A registered nurse then abstracted the medical record using a modified RAND abstraction form.21,22 Abstracted data included elements required to determine the RAND appropriateness score,20-22 including the Parsonnet surgical severity score used in the RAND analysis. These elements include coronary anatomy, left ventricular ejection fraction, specified comorbid medical conditions, and features of the clinical presentation such as time from infarction, presence of persistent pain, and whether medical therapy had been maximized. We also collected information about patient characteristics that might influence the decision to revascularize, including comorbidity as measured by Charlson et al,26 use of cigarettes, and alcohol abuse.

The diagnosis of acute MI required 2 of the following 3 criteria: (1) chest pain, (2) characteristic electrocardiographic changes, and (3) elevation of creatine kinase cardiac isoenzyme or unfractionated creatine kinase with a characteristic rise and fall. The diagnosis of unstable angina required 1 of the following: (1) in patients with previously undergone a procedure when the indication was appropriate and necessary.

Of 3137 potentially eligible patients identified from the Patient Treatment File, 535 were black. We requested the medical records for all 535 black patients, of which 414 (77%) were available. We identified a medical record for a matched white patient for each black patient medical record, based on age, admitting diagnosis, and medical center. When the medical record of a matched white patient could not be located or was ineligible, we requested the medical record of another matching white patient. In total, we requested 710 medical records for white patients and received 517 (73%). Of the 1245 medical records requested, 931 (75%) were received and reviewed. We excluded 265 medical records from the analyses. A previous revascularization procedure (51% of black vs 63% of white excluded patients) followed by other ad-
stable angina, an increase in intensity, duration, or frequency of angina occurring at rest; or (2) in patients without previous angina, an initial episode occurring at rest or new-onset exertional angina unrelieved by rest. The ejec-
tion fraction was determined using the results of contrast ventriculography, a multigated acquisition scan, or echo-
cardiography performed during the admission. If more than 1 of these was performed, the order given previously de-
termined the one used.

We defined coronary anatomy using the cardiac cath-
erization report. If it could not be located, we used the postcatheterization note recorded by the most senior car-
diologist. We considered a significant coronary obstruction to be present if there was 70% or greater stenosis (lu-
menial diameter) in at least 1 major epicardial vessel or 50% or greater stenosis in the left main coronary artery. For de-
scriptive statistics, we rated coronary artery obstructions as severe if the left main coronary artery was significantly stenosed or if all 3 major arteries had stenoses. We con-
sidered the involvement of 1 or 2 arteries, where 1 was the proximal left anterior descending artery, to be moderate dis-
ease. We classified patients with 1 or 2 stenosed vessels who did not meet the criteria for severe or moderate disease as having mild disease.

We considered comorbid diagnoses as present if a phy-
sician documented their presence in the medical record and used the method of Charlson et al28 to assign comorbidity on an ordinal scale (0, 1, 2, or 3) based on the number and severity of comorbid conditions. We categorized surgical risk as low, moderate, or high using a version of the Par-
sonnet surgical risk score, as modified by RAND.29 Alcohol abuse was considered present if the social or medical history documented alcohol abuse, tolerance, depend-
ence, heavy alcohol use, alcoholism, or any medical con-
ditions referred to as alcoholic or secondary to alcohol use. We also coded alcohol abuse to include patients who con-
sumed more than 12 alcoholic drinks per week.

Following abstraction, the medical record was re-
viewed by 1 of 3 board-certified internists (J.C., J.W., or C.B.G.) who assigned the admission to one of the specific RAND indications for revascularization. To confirm the accuracy of the process, we reabstracted the same data from the first 64 medical records, and then for a random 10% sample of the remaining medical records. We tested each data element for agreement using the κ statistic. In cases of disagreement, the reviewers met, discussed, and as-
signed an indication by consensus. We computed κ values for all of the specific elements contributing to the RAND appropriateness score. The κ values for the Parsonnet score, assignment of coronary anatomy, and Charlson score were 0.96, 0.81, and 0.67, respectively. The weighted κ for the Charlson score was 0.80. The κ values approached 100% when RAND scores were dichotomized as appropriate vs
not appropriate (equivocal or inappropriate). This was com-
parable with that achieved by developers of the RAND method in their study of appropriateness of CABG and cath-
erization in England.27 The nurse abstractor also re-
corded whether she believed the patient was black to mea-
sure the effectiveness of masking. Of the 666 medical records available for abstraction, the nurse abstractor correctly guessed the race in 59% of the cases (κ = 0.15), with more blacks being categorized as white than whites being cat-
categorized as black.

ANALYSIS

χ² Analyses were used to assess univariate relations be-
tween race and degree of stenosis, RAND appropriateness scores, and revascularization procedures. We used mul-
tivariate polytomous logistic regression to assess the in-
dependent effect of race on CABG and PTCA performed after controlling for differences in RAND appropriateness level. We tested main effects for race and appropriateness and the interaction of race and appropriateness level; site of care; fiscal year; alcohol, drug, and tobacco use; and pre-
senting diagnosis. Kaplan-Meier methods with Breslow sta-
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erization periods.

For unstable angina, the comparable percentages are 33% for blacks and 18% for whites.

Table 1 also presents the clinical characteristics of the study subjects by race. Black patients were more likely to have hypertension, diabetes mellitus, and current or past alcohol abuse. Otherwise, we found no significant differences in factors that might influence decision making about revascularization. These included mean age, left ventricular ejection fraction, operative risk score (Par-
sonnet score), comorbidity score (Charlson index), prior acute MI, chronic obstructive pulmonary disease, pe-
rripheral vascular disease, and cigarette use.

Table 2 shows the distribution of the RAND ap-
propriateness ratings for black and white patients with significant stenoses. There were no significant differences between black and white veterans.

During the 90 days following catheterization, 108 (16%) of the 666 patients underwent CABG. During the 60 days following catheterization, 146 (22%) of the 666 patients underwent PTCA. Three patients underwent both
procedures. When only 539 patients with angiographically demonstrated coronary artery lesions were considered, these percentages increased to 20% for CABG and 27% for PTCA. Black patients were less likely than whites to undergo any revascularization procedure in the entire cohort (28% vs 47%; P < .001). When only patients with angiographically demonstrated coronary artery lesions were considered, the racial differences in revascularization rates persisted (38% vs 54%; P < .001).

RAND appropriateness indications were associated with undergoing a procedure (Table 3). For indications rated as appropriate and necessary for PTCA but not necessary for CABG by RAND criteria, PTCA was performed more often. If the indication favored CABG as the necessary procedure, it was performed more often. However, if PTCA and CABG were both rated as necessary for an indication, then there was no difference in procedure performed. For indications rated as appropriate but not necessary for PTCA and CABG, PTCA was performed more often. Finally, patients with indications rated as equivocal were more likely to undergo PTCA than CABG.

Table 4 depicts the racial differences in procedures performed as black-white odds ratios. In the entire cohort (N = 666), black patients underwent PTCA and CABG significantly less often than white patients. When the analysis was limited to patients with any significant stenoses (>50%), black patients still underwent PTCA and CABG less often than whites. Table 4 also presents black-white comparisons stratified by the RAND appropriateness rating of the indication for procedure use. Black patients underwent significantly fewer PTCA procedures for equivocal indications and fewer CABG procedures when CABG was judged appropriate and necessary but PTCA was not.

We present the results of a stepwise polychotomous logistic regression in Table 5 for the different RAND indications. We removed patients with no angiographically demonstrated coronary artery lesions from these multivariate analyses. The model included admitting diagnosis, RAND appropriateness rating, site, alcohol abuse, fiscal year, Charlson score, and Parsonnet score. The degree of coronary stenosis was highly correlated with the RAND scores and was not included in the analysis. The stepwise polychotomous logistic regression for the patients with equivocal or inappropriate RAND indications revealed that only race remained in the model. As reported in Table 4, the black-white odds ratio for unappropriateness was 2.76 (95% CI: 1.8-4.1).

*Appropriateness ratings were developed by the RAND Corporation, Santa Monica, Calif. PTCA indicates percutaneous transluminal coronary angioplasty; CABG, coronary artery bypass grafting; only PTCA necessary, an indication for which PTCA would be appropriate and necessary but CABG would be appropriate and not necessary; only CABG necessary, an indication for which CABG would be appropriate and necessary but PTCA would be inappropriate and not necessary; either necessary, an indication for which either PTCA or CABG would be appropriate and necessary; neither necessary, an indication for which neither PTCA nor CABG would be necessary; equivocal, an indication for which PTCA and CABG are equivocal; and inappropriate, an indication for which PTCA and CABG are inappropriate.

†Percentages are determined from the totals for patients with disease: n = 240 for black patients, and n = 299 for white patients. Percentages may not total 100 because of rounding.

Table 1. Comparisons of Black and White Study Patients

Table 2. Racial Differences in Appropriateness Ratings

Table 3. Appropriateness Ratings

Table 4. Racial Differences in Appropriateness Ratings

Table 5. Stepwise Polychotomous Logistic Regression

* Data are given as number (percentage) of patients unless otherwise indicated.
†Percentages may not total 100 because of rounding.
‡n = 320 for black patients, and n = 326 for white patients.
In our comparison of black and white male patients matched on age, race, admitting diagnosis, and medical center, we found that black patients underwent CABG or PTCA less often than whites. This difference is similar in magnitude to that seen in studies using administrative data from the Veterans Health Administration\textsuperscript{10,11} or in studies of single institutions.\textsuperscript{17} Further adjustment controlling for differences in comorbidity, severity of CAD, and operative risk using the RAND appropriateness criteria still revealed racial variation for some indications. The racial difference was greatest when clinical circumstances or indications for PTCA were equivocal. In addition, when the indication for CABG was clearly appropriate and necessary, black patients still did not undergo the procedure at the same rate as white patients. Thus, when the indication for CABG was most clear and most likely to offer a survival benefit, blacks treated in these 6 VAMCs underwent these procedures less often than whites.

Our study had several important strengths. First, we gathered all data necessary to stratify the clinical appropriateness of procedure use according to the appropriateness classification system developed by RAND. This objective approach incorporates such important features as persistence of chest pain despite maximal medical therapy, length of time following MI, and a formal assessment of surgical risk. It has been widely used in studies\textsuperscript{28} of appropriateness and has been reproducible with rates of agreement for inappropriate use and nec-

### Table 3. Revascularization Procedures for Black and White Veterans*  

<table>
<thead>
<tr>
<th>Appropriateness Rating†</th>
<th>No. of Patients in the Category (Black/White)</th>
<th>PTCA</th>
<th>CABG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total (N = 146)</td>
<td>Black (n = 56)</td>
<td>White (n = 90)</td>
</tr>
<tr>
<td></td>
<td>Black (n = 56)</td>
<td>White (n = 90)</td>
<td></td>
</tr>
<tr>
<td>Only CABG necessary</td>
<td>166 (77/89)</td>
<td>9 (12)</td>
<td>8 (9)</td>
</tr>
<tr>
<td>Either necessary</td>
<td>59 (24/35)</td>
<td>10 (42)</td>
<td>11 (32)</td>
</tr>
<tr>
<td>Neither necessary</td>
<td>80 (35/45)</td>
<td>17 (49)</td>
<td>19 (42)</td>
</tr>
<tr>
<td>Equivocal</td>
<td>171 (81/90)</td>
<td>13 (16)</td>
<td>33 (37)</td>
</tr>
<tr>
<td></td>
<td>Total (N = 105)</td>
<td>Black (n = 35)</td>
<td>White (n = 70)</td>
</tr>
<tr>
<td></td>
<td>Black (n = 35)</td>
<td>White (n = 70)</td>
<td></td>
</tr>
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<td>33 (37)</td>
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</table>
|                         | Total (N = 666ystem; CABG, coronary artery bypass grafting.)  
†Data were not calculated because no black patients underwent CABG in this stratum.  
§Significant (P < .01) different from 1.0.  
‡Appropriateness ratings were developed by the RAND Corporation, Santa Monica, Calif. PTCA indicates percutaneous transluminal coronary angioplasty; CABG, coronary artery bypass grafting.  
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### Table 4. Univariate Black-White Odds Ratios for Revascularization*  

<table>
<thead>
<tr>
<th>Variable</th>
<th>PTCA</th>
<th>CABG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall (N = 666)</td>
<td>0.48 (0.32-0.70)†</td>
<td>0.38 (0.24-0.60)†</td>
</tr>
<tr>
<td>Patients with any stenosis (n = 359)</td>
<td>0.58 (0.42-0.81)†</td>
<td>0.47 (0.30-0.74)†</td>
</tr>
</tbody>
</table>

### Table 5. Multivariate Models for the 359 Patients With Appropriate Indicators*  

<table>
<thead>
<tr>
<th>Variable</th>
<th>PTCA</th>
<th>CABG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Across all RAND indications (n = 359)</td>
<td>0.86 (0.51-1.45)</td>
<td>0.60 (0.35-1.06)</td>
</tr>
<tr>
<td>By RAND indication† (n = 54)</td>
<td>0.34 (0.09-1.31)</td>
<td>‡</td>
</tr>
<tr>
<td>Only CABG necessary (n = 166)</td>
<td>0.95 (0.29-3.10)</td>
<td>0.42 (0.20-0.86)§</td>
</tr>
<tr>
<td>Either necessary (n = 59)</td>
<td>4.50 (0.91-22.29)</td>
<td>2.26 (0.42-12.11)</td>
</tr>
<tr>
<td>Neither necessary (n = 80)</td>
<td>1.33 (0.44-4.03)</td>
<td>0.67 (0.34-5.35)</td>
</tr>
</tbody>
</table>

*Appropriate indicators were determined by the RAND Corporation, Santa Monica, Calif. PTCA indicates percutaneous transluminal coronary angioplasty; CABG, coronary artery bypass grafting.  
†Each category is defined in the first footnote to Table 2.  
‡Data were not calculated because no black patients underwent CABG in this stratum.

§Significant (P = .03) difference.
necessary use scenarios of greater than 90%. To our knowledge, no prior study of racial variation has been able to control for such a wealth of potentially important clinical information. Second, we studied only patients with unstable angina and MI who had undergone coronary angiography. This assured a relatively homogeneous population in whom the clinicians involved were seriously considering the possibility of revascularization. Third, by studying patients admitted to VAMCs, we essentially eliminated financial incentives for procedure use among the treating clinicians and risk of financial catastrophe for the patients. Finally, by selecting 6 VAMCs from across the country, with large differences in the racial makeup of the population served and the tendency to perform procedures, we enhanced the generalizability of our results.

Although many studies have documented racial variation in revascularization rates, only a few have been able to control for such important clinical details as coronary anatomy. The results of these studies are generally consistent with our own. In a single-institution study, Peterson et al\(^\text{17}\) found that, after controlling for differences in coronary anatomy, blacks and whites were equally likely to undergo PTCA but that whites were more likely to undergo CABG. This difference was found even among patients who would be predicted to have a survival benefit with CABG based on the severity of their disease. Our study population differs from that of Peterson et al, who studied patients at a single institution, where the physicians and hospital were compensated on a predominantly fee-for-service basis. In addition, although their study included data regarding coronary anatomy and presenting characteristics, it lacked other details of the clinical presentation that were included in our study. Johnson et al\(^\text{18}\) also had consistent findings in their study of a large cohort of patients presenting to emergency departments with chest pain, many of whom eventually underwent coronary angiography. Although the number of blacks was quite small, they found that blacks were less likely to undergo CABG than whites, even after controlling for coronary anatomy. They did not report data regarding use of PTCA. Although these studies had less complete clinical information, and reflected less diverse populations, the similarity of their results to our own is striking.

Our study has several limitations. First, we relied entirely on written data recorded in the medical record and electronically recorded data in the hospitals’ computerized information systems. We suspect documentation was incomplete concerning information about plans for intervention and reasons a recommended procedure did or did not actually occur. Clinicians who decide not to perform a procedure may be more likely to record comorbidities, which would justify their conservative approach. Second, we did not review actual cardiac catheterization films, making it possible that the race of the patient influenced the reporting of the actual significance of lesions. However, the catheterization film interpretation process at the study centers suggests that the reader in many cases does not know the race of the patient. Third, we evaluated practice in only 6 VAMCs. The population served by these VAMCs may be different from that treated in other settings. Our study sites, however, were chosen to represent various regions and varied in the proportion of the population served that is black. Furthermore, the fact that the odds ratios seen in our study were similar to odds ratios seen in studies in the private sector suggests that the racial differences in procedure use have similar mechanisms in both settings. Finally, we received 73% and 77% of medical records for white and black patients, respectively, and our sample may represent a biased sample. Many of the missing medical records in our study are for patients from smaller VAMCs who refer to the larger centers for invasive procedures and whose medical records were returned to the VAMC of origin. Patients from these smaller outlying centers are underrepresented in our sample, but we believe that our racial comparisons are still valid.

The RAND classification system itself has limitations. Since the method assigns each case to one of a finite number of indications, it cannot account for all the subtleties of clinical presentation that some would argue could affect decision making. Thus, an expert clinician reviewing an individual case might well come to a different conclusion regarding appropriateness. However, the experts who developed the system were asked to specify indications that were homogeneous, ie, no other clinical information would be needed to determine whether a procedure was appropriate. Moreover, we believe that it is unlikely that any misclassification would have differentially affected black and white patients. To maintain consistency, we used a single version of the RAND method, developed using data available in 1990. The ratings have since undergone revisions in response to changes in expert opinion regarding appropriateness of procedure use. Although these changes might have changed the proportion of patients for whom revascularization was considered appropriate, we do not expect them to affect black and white patients differently.

Finally, our study could not identify how selection factors operating before the decision to perform catheterization would have affected our findings. In a previous study,\(^\text{10}\) no racial difference in catheterization rates among white and black patients admitted for acute MI or unstable angina was found. We specifically selected our diagnoses to identify a population in whom the chances of admission to the hospital, once one presents for examination, are likely to be similar and high.

It is unclear whether the disparity in procedure use affects patient outcomes. We found no racial difference in 1- and 5-year mortality. Some studies, however, have suggested that black patients have a poorer prognosis than white patients following MI\(^\text{19}\) or bypass surgery.\(^\text{20}\) Thus, although well-chosen candidates for revascularization benefit from these procedures,\(^\text{31}\) black patients may fare better with fewer unnecessary procedures. Peterson et al\(^\text{11}\) found that, although blacks underwent fewer procedures, they had better 30-day post-MI survival but similar long-term survival. Blacks had equal inhospital mortality in the Myocardial Infarction Triage and Intervention Registry despite undergoing fewer angioplasty and bypass procedures.\(^\text{32}\) Likewise, black patients in the Thrombolysis in Myocardial Infarction III registry were less likely to experience death or recurrent MI at 6 weeks after the
index event, although they underwent fewer invasive cardiac procedures. 33

If this difference in procedure use reflects poorer access to procedures that may have lifesaving benefits, then prompt action to increase access for blacks seems warranted. If this difference exists because white patients who have equivocal indications for surgery are more likely to elect revascularization than similar blacks, then this difference may simply reflect differences in attitudes and preferences toward invasive procedures. In a study of male veterans in the outpatient and inpatient setting, we found that whites were more likely than blacks to favor surgery when presented with clinical scenarios showing that revascularization improved symptoms or improved survival. 34 Similarly, blacks were less likely than whites to state they would undergo PTCA or CABG if their physician recommended the procedure.

We have shown that racial differences in clinical factors do not fully explain the black-white difference in a cohort of patients with acute MI or unstable angina. We believe that future studies in this area should directly address the physician-patient interactions that lead to a physician’s decision to offer revascularization and the patient’s decision to accept it. This would include attention to patient preferences, physician-patient communication, and trust.

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