Interventional Cardiology

Influence of Racial Disparities in Procedure Use on Functional Status Outcomes Among Patients With Coronary Artery Disease

Padma Kaul, PhD; Barbara L. Lytle, MS; John A. Spertus, MD, MPH; Elizabeth R. DeLong, PhD; Eric D. Peterson, MD, MPH

Methods
We identified a prospective cohort of 1534 white and 337 black patients undergoing cardiac catheterization between August 1998 and April 2001. Health status was assessed at baseline and 6 months with the Short-Form 36 (SF-36) Health Survey and the Seattle Angina Questionnaire (SAQ) Angina Frequency Scale. Compared with whites, blacks received fewer coronary revascularization procedures (52.5% versus 66.0%; P<0.01). By 6 months, blacks had similar mortality (odds ratio, 1.03; 95% CI, 0.57 to 1.9) but worse scores in 5 SF-36 domains (physical, social, role physical, role emotional, and mental health function). Blacks also reported higher rates of angina at 6 months than whites (34.2% versus 24.6%; P<0.01). After adjustment for baseline functional status and clinical and demographic variables, blacks had significantly worse summary physical component scores, summary mental component scores, and SAQ Angina Frequency Scale scores. However, differences in physical component summary scores and SAQ scores between blacks and whites were no longer significant after adjustment for revascularization status.

Conclusions—Our study is among the first to document greater symptoms and functional impairment among black cardiac patients relative to whites. Differential use of coronary revascularization may contribute to the poorer functional outcomes observed among black patients with documented coronary disease. (Circulation. 2005;111:1284-1290.)

Key Words: ethnic groups ■ coronary disease ■ health status ■ quality of life

Studies have consistently found that black cardiac patients receive fewer coronary revascularization procedures relative to their white counterparts.1-14 The consequences of these racial disparities in cardiac procedure use remain unclear, however. Although certain studies3,15 have associated lower procedure use among blacks with lower long-term survival rates, others have not.16-18 Beyond potential impacts on survival, differential use of coronary revascularization also may affect patient symptoms, functional status, and overall quality of life.19,20 To date, however, there has been no information on the association of racial differences in revascularization and subsequent patient symptoms or functional outcomes.

We therefore undertook a longitudinal assessment of clinical outcomes, angina symptoms, and functional status among black and white patients with coronary disease at cardiac catheterization. We also examined the use of cardiovascular procedures in the 2 racial groups and determined the extent to which revascularization affected health status outcomes.

Background—Although black cardiac patients receive fewer revascularization procedures than whites, it is unclear whether this has a detrimental impact on outcomes. The objective of our study was to compare 6-month functional status and angina outcomes among blacks and whites with documented coronary disease and to assess whether differential use of revascularization procedures affects these outcomes.

Background—Although black cardiac patients receive fewer revascularization procedures relative to their white counterparts.1-14 The consequences of these racial disparities in cardiac procedure use remain unclear, however. Although certain studies3,15 have associated lower procedure use among blacks with lower long-term survival rates, others have not.16-18 Beyond potential impacts on survival, differential use of coronary revascularization also may affect patient symptoms, functional status, and overall quality of life.19,20 To date, however, there has been no information on the association of racial differences in revascularization and subsequent patient symptoms or functional outcomes.

We therefore undertook a longitudinal assessment of clinical outcomes, angina symptoms, and functional status among black and white patients with coronary disease at cardiac catheterization. We also examined the use of cardiovascular procedures in the 2 racial groups and determined the extent to which revascularization affected health status outcomes.

Methods
Between August 1998 and April 2001, patients aged ≥45 years treated at Duke University Medical Center and diagnosed with significant coronary artery disease (CAD) (≥1 vessel with ≥75% stenosis) by elective diagnostic cardiac catheterization were enrolled in a prospective longitudinal assessment of functional outcomes. Patients with congenital heart disease, primary valvular disease, prior coronary artery bypass grafting (CABG), or percutaneous intervention (PCI) within the previous 6 months were excluded from the study. Patient race was based on patients’ self-reported primary classification. Those whose race was classified as other than black or white were excluded. The Duke University Medical Center institutional review board approved the study protocol. Eligible patients were approached to participate in the study, and informed consent was obtained. The rate of agreement to participate in the study was high among both white and black patients (85% and 81%, respectively). There was no difference in 6-month mortality rate among patients who agreed to participate and those who refused to participate in the study. The final study sample consisted of 1871 patients, of whom 1534 were white and 337 were black (Figure 1).

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1284
Data Collection and Follow-Up
The following detailed demographic and clinical data were abstracted from the patients’ medical records at the time of cardiac catheterization.

Demographic Variables
These variables included age, sex, marital status, years of education, and insurance status.

Clinical Variables
Clinical variables included body mass index, history of myocardial infarction (MI), acute MI, congestive heart failure, valve disease, cerebrovascular disease, peripheral vascular disease, hypertension, chronic pulmonary disease, diabetes mellitus, arthritis/degenerative joint disease, cancer, hyperlipidemia, current smoking, substance abuse, depression, anxiety, end-stage renal disease, creatinine levels, and ejection fraction. In addition to these comorbidities, the extent of coronary disease was summarized by both the number of diseased vessels and the Duke CAD index (a detailed characterization of disease severity incorporating the location and severity of stenoses).21

Treatment
Revascularization status, ie, whether the patient had undergone PCI or CABG, was assessed during both the index hospital stay (when the diagnostic cardiac catheterization was performed) and during the 6-month follow-up period. At Duke University Medical Center, decisions about revascularization are made by the cardiology service. Within this service, there is no distinction between private and public service, and there is no difference in care by patients’ ability to pay or their socioeconomic status. In addition to revascularization, rates of use of evidence-based medications, namely, aspirin, β-blockers, ACE inhibitors, and lipid-lowering agents, were assessed.

Functional Status Measures
Baseline health-related quality of life surveys were conducted by trained interviewers within 24 hours of diagnostic catheterization using validated instruments: the Seattle Angina Questionnaire (SAQ) Angina Frequency Scale22 and the RAND Short-Form 36 (SF-36) Health Survey.23 The SAQ Angina Frequency Scale22 is an assessment of the presence of angina, its frequency, and the number of times the patient had to take nitroglycerin for angina. The scale ranges from 0 to 100, with higher scores indicating better functional status and quality of life. The RAND SF-36 provides information on 8 domains: physical functioning; role limitations due to physical problems; bodily pain; general health perception; vitality; social functioning; role limitations due to emotional problems; and mental health. The SF-36 scores range from 0 to 100, with higher scores indicating better health. These domain scores are further aggregated to calculate the physical and mental component summary (PCS and MCS, respectively) scores.24,25

Trained personnel conducted 6-month assessments via structured telephone interviews. Interview content included subsequent cardiac hospitalizations or revascularization procedures, medication use, and the health status measurements collected at baseline. Reported cardiac events and revascularization procedures were confirmed via hospital medical records. Complete baseline and 6-month functional assessment was available for 89% of white patients and 88% of black patients (Figure 1).

Clinical Outcomes
In addition to functional status outcomes, data on mortality status and on whether the patient was rehospitalized within 6 months were collected. A composite end point of 6-month death/MI was defined as death or rehospitalization for MI.

Statistical Analysis
Demographic and clinical characteristics of black and white patients were compared with the use of χ² tests for categorical data and t tests and nonparametric Mann-Whitney tests for continuous variables. Logistic regression analysis was used to examine the association of race and revascularization status, 6-month mortality, and a composite outcome of 6-month death and hospitalization for (repeated) MI, after adjustment for the aforementioned baseline demographic and clinical characteristics.

Baseline and 6-month functional status between the 2 racial groups was compared by t tests. Linear regression was used to examine whether race was a predictor of 6-month SF-36 domain scores and SAQ Angina Frequency Scale scores after adjustment for demographic and clinical variables, as well as baseline scores for each domain.

We conducted sequential multivariable regression analyses to determine the impact of race on functional outcomes (SF-36 PCS and MCS scores and the SAQ Angina Frequency Scale). Three sequential linear regression models were developed for each outcome: the first examined the unadjusted relationship between race and each outcome; the second examined this relationship after adjustment for baseline functional status, baseline demographic, and clinical factors; and the third examined this relationship after adjustment for both baseline factors and revascularization status. All analyses were performed with the use of SPSS (version 11.5).

Results
Baseline Characteristics and Functional Status
Table 1 provides a comparison of baseline characteristics between the 1534 white and 337 black study patients. Blacks were younger, more likely to be female, less likely to be married, and had slightly lower education levels than whites. Black patients had higher rates of congestive heart failure, hypertension, diabetes, substance abuse, and renal disease than white patients but lower rates of hyperlipidemia and depression. There was no significant difference in the presence of coronary disease severity on the basis of the classification of patients’ coronary anatomy as having multivessel disease or on the basis of their CAD index between the 2 groups.

At the time of cardiac catheterization, baseline physical, social, and emotional role functioning was worse among blacks than whites (Table 2). In contrast, black patients reported better vitality scores (46.4 versus 40.8; \(P<0.01\)). There were no significant differences in either PCS or MCS scores between the 2 groups. There were no significant differences between the 2 groups in angina symptoms or in the SAQ Angina Frequency Scale scores.
TABLE 1. Comparison of Baseline Characteristics Among White and Black Patients

<table>
<thead>
<tr>
<th>Description</th>
<th>White (n=1534)</th>
<th>Black (n=337)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td></td>
<td></td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Female</td>
<td>34.9</td>
<td>46.9</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Married</td>
<td>70.1</td>
<td>50.4</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Years of education</td>
<td>12 (11, 15)</td>
<td>11 (8, 12)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Insurance status: Medicare</td>
<td>59.7</td>
<td>57.3</td>
<td>0.43</td>
</tr>
<tr>
<td>Body mass index</td>
<td>28.4±6.9</td>
<td>29.9±6.9</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>History of MI</td>
<td>47.8</td>
<td>46.9</td>
<td>0.76</td>
</tr>
<tr>
<td>Acute MI</td>
<td>21.3</td>
<td>24.3</td>
<td>0.22</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>16.6</td>
<td>24.9</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Valve disease</td>
<td>11.1</td>
<td>10.4</td>
<td>0.77</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>13.7</td>
<td>15.1</td>
<td>0.49</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>20.1</td>
<td>17.8</td>
<td>0.36</td>
</tr>
<tr>
<td>Hypertension</td>
<td>64.9</td>
<td>81.6</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Chronic pulmonary disease</td>
<td>14.8</td>
<td>12.2</td>
<td>0.23</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>27.1</td>
<td>45.4</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Arthritis/degenerative joint disease</td>
<td>17.7</td>
<td>16.6</td>
<td>0.69</td>
</tr>
<tr>
<td>Cancer</td>
<td>11.3</td>
<td>6.8</td>
<td>0.01</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>61.1</td>
<td>52.5</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Smoking (current)</td>
<td>15.6</td>
<td>16.6</td>
<td>0.68</td>
</tr>
<tr>
<td>Substance abuse</td>
<td>3.2</td>
<td>8.6</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Depression</td>
<td>8.1</td>
<td>4.5</td>
<td>0.02</td>
</tr>
<tr>
<td>Anxiety</td>
<td>3.2</td>
<td>2.1</td>
<td>0.38</td>
</tr>
<tr>
<td>End-stage renal disease</td>
<td>1.6</td>
<td>6.5</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Baseline creatinine, mg/dL</td>
<td>1.0 (0.9, 1.2)</td>
<td>1.2 (0.9, 1.5)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Ejection fraction</td>
<td>56 (45, 66)</td>
<td>52 (38, 61)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Coronary disease severity</td>
<td></td>
<td></td>
<td>0.27</td>
</tr>
<tr>
<td>2-Vessel disease</td>
<td>27.9</td>
<td>25.9</td>
<td></td>
</tr>
<tr>
<td>3-Vessel disease</td>
<td>31.6</td>
<td>36.0</td>
<td></td>
</tr>
<tr>
<td>CAD index</td>
<td>37 (32, 63)</td>
<td>42 (32, 63)</td>
<td>0.76</td>
</tr>
</tbody>
</table>

Continuous variables are expressed as medians (25th, 75th percentile); categorical variables are expressed as percentages.

Patterns of Evidence-Based Medication Use and Treatment

There were no significant differences in the use of aspirin (72% in black and 70% in white; P=0.60), β-blockers (65% in black and 60% in white; P=0.16), and lipid-lowering agents (42% in black and 44% in white; P=0.63) between the 2 groups. However, black patients had higher rates of ACE inhibitor use (51%) than white patients (38%; P<0.01.)

In contrast, rates of PCI (26.8% versus 33.4%; P=0.03) and CABG (26.1% versus 33.7%; P<0.01) during index hospitalization were lower in blacks than whites, respectively. Differences in revascularization rates between whites and blacks were also more marked among those with multivessel disease (Figure 2). By 6 months, the difference in combined revascularization rates remained significant: 54.8% among blacks versus 68.7% among whites (P<0.01). These racial differences in revascularization use at 6 months were significant after adjustment for baseline demographics and clinical characteristics (odds ratio [OR], 0.53; 95% CI, 0.40 to 0.71).

Clinical Outcomes

Clinical status data at 6 months were available for all patients. During the 6-month follow-up period, 38.6% of blacks and 38.7% of whites had been rehospitalized (P>0.99). Six-month mortality rates were 6.5% among black patients and 4.6% among white patients (P=0.17). Similarly, 6-month death/MI composite rates were 10.4% among black patients and 7.3% among white patients (P=0.07). After adjustment for other demographic and clinical characteristics, race was not significantly associated with death (black/white OR, 1.03; 95% CI, 0.57 to 1.9) or with the composite death/MI outcome (OR, 1.10; 95% CI, 0.69 to 1.8).

Six-Month Functional Status Outcomes

Functional status data were available on 1662 patients (89%) who survived to 6 months after diagnostic cardiac catheterization. Compared with patients who responded (n=1662), nonrespondents (n=116, excluding patients who died) were older and had higher rates of congestive heart failure, valve disease, and cerebrovascular disease. In contrast, respondents had higher rates of hyperlipidemia and 3-vessel disease. There was no difference in race among respondents and nonrespondents.

Six-month SF-36 scores and the change in functional scores between baseline and 6 months are presented in Table 3. In general, functional status improved in the 6 months after treatment (medical or revascularization) for both black and white patients. However, after adjustment for baseline clinical factors and functional status scores, black race was associated with statistically significantly worse 6-month SF-36 scores in the following domains: physical functioning (−3.75); role functioning—physical (−7.32); social functioning (−4.86); role functioning—emotional (−5.20); and mental health (−2.84). The PCS and MCS scores were also significantly worse in blacks relative to whites (P<0.01 for both).

Frequency of angina symptoms at baseline and 6 months, overall and among patients with single-vessel and multivessel disease, are presented in Figure 3. Black patients had significantly higher rates of angina compared with white patients at 6 months (34.2% versus 24.6%; P<0.01). These differences in angina symptoms persisted after adjustment for demographic and clinical factors and baseline angina status (adjusted OR, 1.5; 95% CI, 1.1 to 2.0). The racial differences in angina at follow-up were larger among patients with multivessel disease (adjusted black/white OR for angina, 1.8; 95% CI, 1.2 to 2.7). Black patients had worse physical functioning compared with whites in both single-vessel and multivessel patient subgroups.

Impact of Treatment on Functional Status and Angina Symptoms

The unadjusted relationship between race and PCS and MCS scores as well as SAQ Angina Frequency Scale scores are provided in Table 4. Black race was associated with worse outcomes for all 3 dimensions and continued to be associated
with worse outcomes after adjustment for baseline function and demographic and clinical factors. However, after adjustment for revascularization status, race was no longer a significant predictor of either PCS or SAQ Angina Frequency Scale scores.

**Discussion**

The recent report of the Institute of Medicine, titled "Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care," notes that the strongest and most consistent evidence of racial and ethnic disparities in healthcare is to be found in cardiovascular care. However, although studies to date have documented racial differences in the use of diagnostic and therapeutic procedures, whether these care differences result in negative health outcomes among blacks remains unclear. Our study is among the first to document that black patients diag-

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**TABLE 2. Baseline Functional Status by Race Category**

| Description                          | White (n=1534) | Black (n=337) | P  
|--------------------------------------|----------------|--------------|-----
| **SF-36 domains†**                   |                |              |     
| Physical functioning                 | 52.5±29.5      | 47.5±28.8    | <0.01 
| Role functioning—physical            | 33.9±39.6      | 33.3±40.3    | 0.79 
| Bodily pain                          | 55.5±28.7      | 55.0±29.8    | 0.78 
| General health                        | 54.1±23.3      | 50.5±22.0    | 0.01 
| Vitality                             | 40.8±24.0      | 46.4±22.7    | <0.01 
| Social functioning                   | 66.9±30.4      | 62.0±29.2    | <0.01 
| Role functioning—emotional           | 66.5±42.0      | 56.3±44.4    | <0.01 
| Mental health                         | 69.7±20.9      | 68.2±21.0    | 0.25 
| PCS                                  | 35.5±11.3      | 34.7±10.8    | 0.25 
| MCS                                  | 48.4±11.3      | 47.2±11.5    | 0.07 
| Angina in the past month,‡ %         | 65.1           | 66.9         | 0.57 
| Types of activities that bring on angina, % | 9.5           | 8.3         | 0.07 
| Strenuous exertion (heavy lifting, running) | 30.1           | 22.1        | 0.07 
| Moderate exertion (walking, climbing stairs) | 27.6           | 33.6        | 0.07 
| Mild exertion (daily household tasks) | 32.8           | 35.9        | 0.07 
| At rest                              | 66.9           | 66.9         | 0.57 
| SAQ Angina Frequency Scale§          | 75.5±25.1      | 73.6±27.0    | 0.24 

Values are mean±SD unless otherwise noted.

*Comparison of baseline functional scores between blacks and whites.
†Higher score indicates better functional status.
‡Percentage of patients with angina in the last month (SAQ).
§SAQ Angina Frequency Scale is scored between 0 and 100, with higher scores indicating better functional outcomes.

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![Figure 2](http://circ.ahajournals.org/)

**Figure 2.** Revascularization (PCI and/or CABG surgery) status among blacks (n=290) and whites (n=1367) during the initial catheterization hospitalization and at 6 months (overall and by presence of single-vessel/multivessel disease). P values correspond to χ² tests of revascularization rates among black and white patients.
nosed with coronary disease undergo fewer revascularization procedures and have worse angina symptoms and functional status than their white counterparts.

In our examination, after baseline adjustment, black race was associated with worse 6-month outcomes in 5 of the 8 functional status domains (physical function, social function, role physical, role emotional, and mental health). Black patients also reported significantly higher rates of angina at 6 months (34.2%) than whites (24.6%; \( P < 0.01 \)) and scored worse on the SAQ Angina Frequency Scale.

There are multiple potential explanations for the observed differences in functional outcomes between black and white patients.
cardiac patients. First, there were racial differences in demographics, comorbid illness, and disease severity that could have affected downstream functional recovery (Table 1). However, race remained a significant predictor of angina and functional status domains after adjustment for these demographic and clinical differences.

Black patients also reported a greater degree of functional impairment at the time of baseline cardiac catheterization than whites. These differences are consistent with other studies and may reflect delayed presentation or slower clinical evaluation of blacks relative to whites. Variation in pharmacological treatment is another potential contributor to our observed differences in functional outcomes. However, our study found reported use of cardiac medications to be similar between blacks and whites.

Finally, differences in the use of revascularization procedures may have contributed to the observed results. Randomized clinical trials such as Randomized Intervention Treatment of Angina (RITA-2) and Angioplasty Compared with Medical Therapy (ACME) have demonstrated that patients undergoing revascularization procedures have significantly better quality of life outcomes than those treated medically. In our study revascularization appeared to “explain” the racial differences in 6-month functional outcomes. Although the impact is modest, inclusion of revascularization in the multivariable models had an attenuating effect on the impact of race, and it was no longer significantly associated with either the SF-36 PCS scores or the SAQ Angina Frequency Scale scores. There may be several potential explanations for the persistence of racial differences in MCS even after adjustment for revascularization: It may imply that blacks report lower MCS despite care, and there may be other factors intrinsic to race that have not yet been identified that may explain these differences.

The reader should be aware of potential limitations of this study. First, our study documents a single center’s experience, and the extent to which these results are generalizable to the rest of the country remains to be examined. However, other studies have demonstrated similar racial differences in revascularization. Second, race may be a marker for other differences in socioeconomic and social support factors or comorbidities that are not currently captured in the study. Third, although we assessed other potential treatment differences, such as the reported use of medications, we did not have full details on dosing, rates of compliance, or other care aspects such as the frequency with which patients visited their healthcare providers. Finally, we examined outcomes at only 6 months. Several studies have suggested that the impact of differential use of revascularization may be observed in longer-term outcomes. Therefore, the full impact of racial differences in revascularization may only be available by longer-term assessment.

## Conclusion

This study demonstrates significant racial differences in functional outcomes in black patients with documented CAD relative to their white counterparts. Differential use of revascularization procedures appears to contribute to these observed differences in health states. These findings support ongoing efforts designed to reduce racial disparities in cardiac care as a means of improving long-term patient outcome.

## Acknowledgments

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References

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