Impact of availability of hospital-based invasive cardiac services on racial differences in the use of these services

Patrice M. Gregory, PhD, MPH,[a] George G. Rhoads, MD, MPH,[b] Alan C. Wilson, PhD,[c] Kenneth J. O'Dowd, PhD,[d] and John B. Kostis, MD[c] ***New Brunswick, Piscataway, and Trenton, NJ***

Background Reports indicate that black patients are less likely than white patients to receive invasive cardiac services after hospitalization for acute myocardial infarction (AMI). There is still uncertainty as to why racial differences exist and how they affect patient outcomes. This is the first study to focus on the availability of invasive cardiac services and racial differences in procedure use. Study objectives were to (1) document whether racial differences existed in the use of invasive cardiac procedures, (2) study whether these racial differences were related to availability of hospital-based invasive cardiac services at first admission for AMI, and (3) determine whether there were racial differences in long-term mortality rates.

Methods A historical cohort study was conducted with discharge records from all acute care hospitals in New Jersey for 1993 linked to death certificate records for 1993 and 1994. There were 13,690 black and white New Jersey residents hospitalized with primary diagnosis of AMI. Use of cardiac catheterization within 90 days, revascularization within 90 days (percutaneous transluminal coronary angioplasty [PTCA] or coronary artery bypass graft surgery [CABG]), and death within 1 year after admission for AMI were the main outcome measures. Patterns for PTCA and CABG as separate outcomes were also studied. Hospital-based cardiac services available were described as no invasive cardiac services, catheterization only, or PTCA/CABG. To account for payer status and comorbidity differences, patients 65 years and older with Medicare coverage were analyzed separately from those younger than 65 years.

Results Black patients aged 65 and older were generally less likely to receive catheterization and revascularization than white patients, regardless of facilities available at first admission. For patients younger than 65 years, the greatest differences between black and white patients in catheterization and PTCA/CABG use within 90 days after AMI occurred when no hospital-based invasive cardiac services were available. However, use of invasive cardiac procedures within 90 days after AMI was substantially increased if the first hospital offered catheterization only or PTCA/CABG services, among all patients, especially among blacks younger than age 65. No significant racial differences or interactions with available services were found in 1-year mortality rates.

Conclusions Availability of invasive cardiac services at first hospitalization for AMI was associated with increased procedure use for both races. However, use of invasive cardiac procedures was generally lower for black patients than for white patients, regardless of services available. Long-term mortality rates after hospitalization for AMI did not differ between blacks and whites. (Am Heart J 1999;138:507-17.)

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From the [a]Health Services Research Program, Department of Family Medicine, and the [c]Department of Medicine, Robert Wood Johnson Medical School, New Brunswick; [b]New Jersey Graduate Program in Public Health (a joint program with Rutgers The State University of New Jersey), Piscataway; [d]New Jersey Department of Health and Senior Services (NJDHSS), Trenton.

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Reprint requests: Patrice M. Gregory, PhD, MPH, Health Services Research Program, Department of Family Medicine, UMDNJ-Robert Wood Johnson Medical School, Medical Education Building, 1 Robert Wood Johnson Place, New Brunswick, NJ 08903-0019.
E-mail: gregory@umdnj.edu

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Numerous studies have shown that black patients have fewer invasive cardiac procedures after acute myocardial infarction (AMI) than white patients.[1-14] These studies have been conducted on a wide variety of populations from single medical centers, specific geographic regions, and large national cohorts. In many of these studies, blacks were generally only about three fourths as likely to receive cardiac catheterization, two thirds as likely to receive percutaneous transluminal coronary angioplasty (PTCA), and one half as likely to receive coronary artery bypass graft surgery (CABG).

Speculation regarding the reasons for these racial disparities has included differences in severity of disease, out-of-hospital deaths, income level, health insurance status, physician recommendation, patient preferences, physician-patient communication, and racial bias.[15] Our

study is the first of which we are aware that explores the relation between availability of hospital-based invasive cardiac services and racial differences in the use of these services. In a health care environment in which there is increasing concern about access to services for minority populations, the availability of services is a fundamental element in ensuring access to care. Previous work from the Seattle area[16] and New York[17] indicated that cardiac services were much more widely used when patients first presented to hospitals in which these services were available. These studies, however, did not specifically address racial differences in cardiac procedure use in relation to availability of invasive cardiac services.

In this study, we examined use of invasive cardiac services in the 90 days after hospital admission for AMI to (1) document any racial discrepancies in the use of invasive cardiac services, (2) study how racial differences in service use was related to availability of invasive cardiac services at the first hospitalization for AMI, and (3) investigate racial differences in long-term patient outcome after AMI.

Methods

Sources of data

The Myocardial Infarction Data Acquisition System (MIDAS) is a statewide monitoring system that combines hospital billing data and death certificate data to allow follow-up of all patients who have been discharged with AMI from non-federal acute care facilities in New Jersey.[18]

In the absence of unique patient identifiers across files, a probabilistic matching scheme was used to link death certificate information and readmissions for the same patient to the first hospitalization.[19] Sensitivity and specificity of the linkage procedure were roughly estimated in the absence of a true gold standard. The linkage procedure matched death certificates to hospital information with approximate sensitivity of 98%.[20] The sensitivity was indicated by examining the links between the hospital discharge and death certificate files found for those whose hospital discharge status was coded as dead. One would expect that all patients who were coded dead in the discharge file should have had a matching death certificate. The sensitivity when expressed as a percent was calculated as (Number of records coded as discharged dead from the hospital linked to a death certificate record/Total number of records coded with discharge status as dead) × 100. This rough estimate of sensitivity most likely overstated to some degree the actual sensitivity of the linkage scheme. The specificity of the linkage process was determined to be 99% by using death data files from years preceding those of the hospital discharge data.[20] Clearly patients who died the previous year could not have been discharged from the hospital the next year, so no links between discharge and death records would be expected. The lack of distinguishing power of the variables available for linkage, however, resulted in the occurrence of linkages. The specificity, when expressed as a percentage, was calculated as: [1 – (Total number of links made between discharge and death records/Total number of discharge records input)] × 100.

We used the MIDAS data from calendar year 1993 as the basis for this study because it was the most recent year available that allowed for 1-year follow-up of death. The study was approved by the institutional review committees of the New Jersey Department of Health and Senior Services and Robert Wood Johnson Medical School.

Selection criteria

Only non-Hispanic white and black patients discharged in 1993 with primary diagnosis of AMI (International Classification of Diseases Ninth Revision [ICD-9] code 410.0-410.9), aged 30 to 99 years, and zip code of residence within New Jersey were selected for study. Because more than 90% of patients 65 years of age and older were Medicare beneficiaries, those patients in this age group with other types of health insurance were excluded.

The decision to exclude patients without a primary diagnosis of ICD-9 410 was based on a validity study of the AMI diagnosis with the MIDAS data previously published.[6] In this review of a stratified random sample of 669 medical records, 20% percent of the 30 charts in which ICD-9 410 appeared as one of the secondary diagnoses showed no evidence of AMI, even in the patient's recent past. Of the 519 charts with AMI as the primary diagnosis, there were 33 charts (6.36%) with no evidence of AMI. The group without AMI as the primary diagnosis was expected to have an unacceptably high error rate for the diagnosis of AMI and was excluded from this study.

Definitions of variables

The first discharge with a primary diagnosis of AMI in the calendar year for each selected patient was considered the first hospitalization. There could be no admissions for AMI found to be within 30 days before this first hospitalization.

The outcome variables of interest were ICD-9 codes in any of the 8 procedure fields indicating use of cardiac catheterization (catheterization: 37.22-37.23, 88.53, 88.55-88.56) or revascularization (PTCA, 36.00-36.06; CABG, 36.10-36.16, 36.19).

The revascularization procedures PTCA and CABG were considered jointly because of the lack of any a priori hypotheses regarding invasive cardiac service availability and racial differences in the use of these high technology procedures. In New Jersey, a hospital equipped to provide PTCA must also be equipped to provide CABG. Combining the 2 procedures as a single outcome was also advantageous for statistical reasons because of the relatively small numbers of each procedure, especially CABG.

We used follow-up periods of 90 days from the first AMI admission date for procedure use. Death within 1 year of AMI admission was another main study outcome.

The 2 independent variables of greatest interest were race and type of cardiac services available at first hospitalization. Race was defined on the hospital record as black (non-Hispanic) or white (non-Hispanic) at first discharge. The type of invasive cardiac services available at the first hospital (1) were no invasive cardiac services, (2) cardiac catheterization only, and cardiac catheterization, angioplasty, and bypass graft surgery (PTCA/CABG). In 1993, 25 of the 84 acute care hospitals were equipped to perform cardiac catheterization in New Jersey. Of these, 13 also had the services to perform PTCA and CABG.

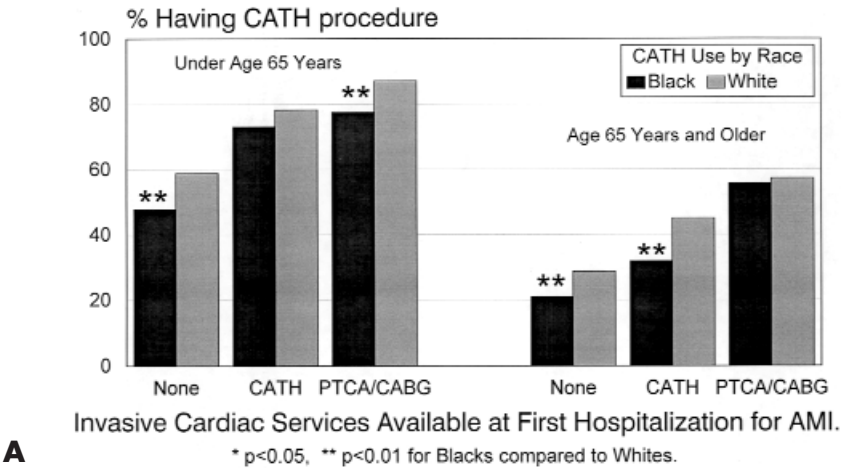
Table I. Percentages of patients with comorbid conditions used to construct the MIDAS comorbidity score

Description of condition	%
Chronic angina with ischemic heart disease	48.5
Unstable angina and non-AMI acute ischemia	3.5
Insufficiency or stenosis of mitral, aortic, pulmonary, and tricuspid valve and endocarditis	9.0
Prosthetic valve	0.3
Old myocardial infarction	6.4
All forms of heart failure except isolated right heart failure hypertension with CHF	34.9
Essential HTN, benign secondary HTN, secondary HTN without specified complications, malignant HTN without specified complications	34.5
HTN with complications to heart, kidneys or with encephalopathy	8.2
Specified peripheral vascular disease	3.4
Ruptured aneurysms in the peripheral circulation	0
Cerebrovascular accidents	5.0
Chronic pulmonary disease	12.6
Lung disease associated with right-sided CHF	0.2
Chronic debilitating or degenerating neurologic disorders	2.3
All dementias	1.3
Hemiplegia, quadriplegia, diplegia, monoplegia, cauda equina syndrome, unspecified paralysis	1.3
Most thyroid disease, pituitary dysfunction, adrenal dysfunction	4.1
Uncomplicated diabetes mellitus	18.0
Diabetic ketoacidosis or diabetic coma	0.3
Diabetes with end organ damage	7.2
Chronic renal failure without dialysis	1.6
Chronic liver disease without specified complications	0.4
Chronic liver disease with complications	0.2
GI ulcers without bleeding	1.8
GI ulcers with bleeding	0.3
GI bleeding not specified as caused by ulcers	2.0
Inflammatory bowel disease	0.2
All cancers	2.3
Minor arrhythmias	24.6
Minor conduction abnormalities	7.3
Conduction disorders usually requiring pacemakers	2.4
Alcohol and drug abuse or dependence	1.7
Major psychoses	1.1
Chronically debilitating or degenerating neurologic disorders	1.6
Mental retardation	0.1
Chronic arthritis	5.8
Connective tissue diseases	0.4
Disorders of coagulation and homeostasis	1.0
Pneumonia	4.0
Urinary tract infection	6.6
Sepsis or bacteremia	1.7
Hypotension or hypovolemia	13.0
Syncope, collapse and nontraumatic shock	5.2
Fluid or electrolyte disorders	15.1
Specified peripheral vascular disease	3.1
VT, VF, cardiac arrest	14.6

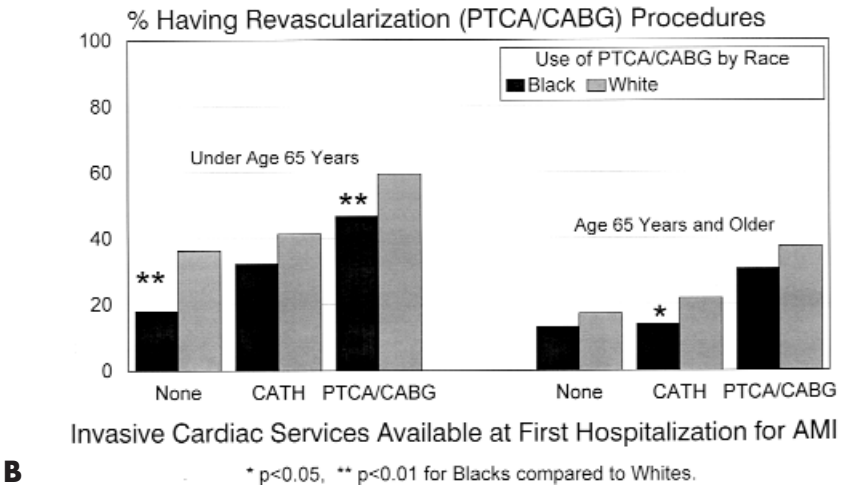
Methods used to construct MIDAS comorbidity score are those described by Normand.[21]
CHF, Congestive heart failure; *HTN,* hypertension; *GI,* gastrointestinal; *VT,* ventricular tachycardia; *VF,* ventricular fibrillation.

Demographic variables such as sex were considered as important potential confounding variables. Age was regarded as a major factor because of its implications for health insurance status, comorbidity, and potential bias against invasive interventions. Patients with AMI aged 65 and older were analyzed separately from those younger than age 65. The likelihood of procedure use was markedly higher and mortality rate lower among patients younger than age 65 than among those aged 65 and older. Patients aged 65 and older were almost exclusively insured by Medicare (more than 90%). Because health insurance status was thought to be an important confounding variable for those younger than age 65, the 2 age groups were considered separately to use health insurance status more appropriately as a covariate in the younger age stratum. The group of patients aged 65 and older had greater comorbidity than those younger than age 65. To avoid as much as possible residual confounding by comorbidity that is a common problem with administrative data lacking clinical details, we chose to separate the younger from the older age groups. Among patients younger than age 65, age was determined to fit the models best when further categorized as follows: 30 to 44 years, 45 to 54 years,

Figure 1



A



B

Use of cardiac catheterization and revascularization according to invasive cardiac services available at first hospitalization for AMI. *None,* No invasive cardiac services available; *CATH,* cardiac catheterization only.

and 55 to 64 years (reference group). To use age as a covariate in the elderly patient group, it was categorized for optimal model fit as 65 to 74 years (reference group), 75 to 84 years, and 85 to 99 years.

Health insurance status was based on primary payer coded for patients younger than age 65. Categories of health insurance status were Medicaid, Medicare, no insurance, HMO or PPO, and private fee-for-service (reference group). Medicare was the only payer included for those aged 65 and older.

The anatomic location of the infarct coded in the hospital discharge data was used as a proxy for severity of the infarct in the absence of more detailed clinical information. The infarct location was consistently related to short-term survival rate. The classification scheme was based on (1) other/unspecified locations (ICD-9 410.8-410.9), (2) anterior (ICD-9 410.0, 410.1, 410.5), (3) inferior or inferolateral (ICD-9 410.2-410.4, 410.6), or (4) subendocardial (ICD-9 410.7). The percentages of patients who died after just 3 days according to location of primary infarct were 17.8%, 7.6%, 5.0%, and 1.9%, respectively, for other/unspecified, anterior, inferior, and subendocardial. Anatomic location of the AMI was still indicative of death at 90 days with respective death rates for other/unspecified, anterior, inferior, and subendocardial of 35.5%, 19.9%, 12.7%, and 12.3%.

An index of severity of comorbidity (the MIDAS comorbidity score) was calculated with methods by Normand based on 46 comorbid conditions judged by an expert panel to influence prognosis after AMI.[21] The conditions considered in constructing the comorbidity score are listed in Table I along with

Table II. Characteristics of study patients according to race for each patient age group

	Younger than 65 y		65 y and older	
	Black (n = 625)	**White (n = 4647)**	**Black (n = 592)**	**White (n = 7826)**
Patient characteristics				
Mean age (y)	53.6*	54.6	75.8*	76.9
Female (%)	40.6*	24.7	62.5*	48.2
Medicare (%)	12.8*	7.1	100	100
Medicaid (%)	10.4*	2.2	–	–
Self pay (%)	20.3*	10.1	–	–
HMO (%)	13.1*	17.0	–	–
Indemnity (%)	39.5*	67.5	–	–
Hospital stay				
Mean length of stay (d)	9.0*	7.6	12.0*	10.3
90-Day readmission (%)	34.6*	47.4	19.9*	26.7
Mean MIDAS				
Comorbidity score	11.1*	8.3	17.4	16.5
Other/unspecified infarct	5.9	4.8	10.3	10.1
Anterior infarct	29.4	28.5	24.2	27.2
Inferior infarct	30.9*	40.8	27.0	28.2
Subendocardial infarct	33.8*	25.8	38.5	34.5
Catheterization available (%)	52.2*	46.1	52.3*	44.6
PTCA/CABG available (%)	50.3*	41.8	30.5	18.8
Procedure use/death				
Catheterization within 90 days (%)	62.4*	69.8	34.0*	38.3
PTCA within 90 days (%)	21.0*	28.9	10.5	11.5
CABG within 90 days (%)	10.4*	15.5	8.8	11.2
PTCA/CABG 90-days (%)	30.1*	42.9	18.8	22.1
PTCA/CABG only among those with catheterization (%)	45.9*	58.1	52.2	54.4
1-Year mortality rate (%)	12.2	9.8	32.4	32.9

*$P < .01$ for comparison of blacks and whites in given age group with χ^2 or Wilcoxon rank sum tests.

the percentages of patients in our study group who had the condition at initial discharge.

Data analysis

Distributions of the outcomes, as well as demographic, social, and clinical characteristics, were compared according to race and cardiac services available with χ^2 or Wilcoxon rank sum tests. To adjust for potential confounding variables, maximum likelihood logistic regression models were developed to study the 90-day use of catheterization and PTCA/CABG. Cox proportional hazards regression models were used to study 1-year mortality rate. We considered the 2 revascularization procedures as separate outcomes in post hoc analyses to see if our results were consistent for each procedure.

Results

Selection criteria

The number of patients who met the selection criteria for study was 13,690 of 18,532 patients (73.9%) listed in the MIDAS database for 1993 with primary diagnosis of AMI. More than 80% of the exclusions resulted from the lack of a valid New Jersey zip code; less than 7% resulted from the designation of a racial/ethnic group other than white or black. Of those eligible for study 8418 (61.5%) were aged 65 years and older. There were 1217 blacks and 12,473 whites.

Patient characteristics

Demographic and clinical characteristics of the study patients are shown in Table II. The percentages of patients who were 65 years and older were 50.9% for blacks and 64.3% for whites ($P < .01$). Within each age group, black patients were younger, more often female, and had longer hospital stays and higher MIDAS comorbidity scores than whites. Hospital readmissions within the 90-day follow-up period were significantly less frequent among blacks than whites. Blacks were more often admitted first to hospitals equipped to perform cardiac catheterization and/or PTCA/CABG.

Unadjusted outcomes

Despite being first admitted more often to hospitals offering invasive cardiac services, black patients received relatively fewer invasive procedures than white patients within 90 days of follow-up after AMI (Table II). The percentages of blacks compared with whites were statistically significantly lower for those who received catheterization in both age strata and for those who received PTCA, CABG and the combined outcome of PTCA/CABG among patients younger than 65 years ($P < .01$). Among those younger than age 65, a pattern of relatively fewer revascularization procedures

Table III. Adjusted use of cardiac catheterization and revascularization within 90 days after AMI in blacks compared with whites according to invasive cardiac services at first hospitalization

	Adjusted odds ratio	
	Younger than 65 y	**65 y and older**
90-Day catheterization		
All facilities	0.74 (0.61, 0.90)*†	0.68 (0.56, 0.83)*†
No invasive cardiac services	0.68 (0.53, 0.88)	0.58 (0.42, 0.79)
Catheterization only	0.97 (0.61, 1.57)	0.69 (0.44, 1.07)
PTCA/CABG	0.85 (0.56, 1.32)	0.83 (0.59, 1.17)
90-Day PTCA/CABG		
All facilities	0.63 (0.52, 0.76)*†	0.69 (0.54, 0.86)*†
No invasive cardiac services	0.42 (0.30, 0.57)	0.69 (0.47, 0.98)
Catheterization only	0.85 (0.55, 1.29)	0.71 (0.40, 1.20)
PTCA/CABG	0.86 (0.61, 1.20)	0.67 (0.74, 1.16)
90-Day PTCA/CABG only among patients with catheterization		
All facilities	0.67 (0.54, 0.84)*†	0.82 (0.61, 1.12)*†
No invasive cardiac services	0.42 (0.29, 0.60)	1.13 (0.66, 1.97)
Catheterization only	0.83 (0.52, 1.32)	0.81 (0.42, 1.52)
PTCA/CABG	0.94 (0.68, 1.23)	0.67 (0.44, 1.03)

Adjusted odds ratio is for cardiac services available (if not stratified), age, sex, health insurance (if younger than age 65), anatomic location of primary infarct, and MIDAS comorbidity score with logistic regression. Maximum likelihood 95% confidence intervals are shown in parentheses. White patients were reference group for black patients. Interaction between race and type of service available: *$P > .0025$, †$P < .10$.

for blacks than whites was also found among the subset of patients who had been catheterized. Crude 1-year mortality rate was higher among blacks (12.2%) than whites (9.8%) in the younger than 65 age group, although the difference was not statistically significant. Among patients aged 65 years and older, roughly 33% in both racial groups died within 1 year of hospital admission with primary diagnosis of AMI.

The percentages of blacks and whites receiving cardiac catheterization (Figure 1, *top*) and revascularization (Figure 1, *bottom*) are shown in relation to the type of invasive cardiac services available at first hospitalization. Blacks had lower procedure use than whites at every level of service available. However, for both racial groups, use of these procedures was relatively more frequent within 90 days after AMI, when more services were available at first admission.

Cardiac catheterization in relation to race and service availability

After adjusting for age, sex, health insurance status (for those younger than age 65), anatomic location of primary infarct, comorbidity, and availability of cardiac catheterization services, blacks in both age groups showed significantly lower odds of undergoing catheterization procedures than whites: 26% lower for those younger than 65 years and 32% lower for those 65 years and older (Table III). No statistically significant interactions between race and level of available invasive cardiac services at first admission for 90-day catheterization use were evident ($P > .10$). However, greatest racial disparities in catheterization use were found for both age strata when the first hospital could not provide invasive cardiac services (32% and 42% lower use for Blacks younger than 65 years and 65 years and older, respectively).

Revascularization in relation to race and service availability

Adjusted odds of revascularization within the 90-day follow-up period were significantly lower in blacks than in whites by 37% for those younger than age 65 and 31% for those 65 and older (Table III). Even when considering only those who were catheterized, the odds of revascularization were relatively lower among blacks than whites—significantly lower by 33% for those younger than age 65 (Table III).

Among patients younger than age 65, differences in revascularization rates for Blacks and Whites seemed to depend on the level of invasive cardiac services available at first hospitalization. The discrepancy between races was most striking when no invasive cardiac services were available at the first hospital of record. This interaction was statistically significant ($P < .0025$). Results for patients younger than age 65 showed lower use of revascularization for blacks by more than 50% when the first hospital offered no invasive cardiac services. These differences persisted even considering only those patients who had been catheterized. In contrast, patients younger than 65 years who were first admitted to hospitals with invasive cardiac services showed no significant racial differences in revascularization (Table III).

Among patients aged 65 and older, racial differences in adjusted revascularization rates did not seem to depend on availability of invasive services at first hospitalization.

There were no statistically significant interactions between race and invasive cardiac service availability for PTCA/CABG use overall or when only considering the subset of patients who were catheterized ($P > .10$).

Impact of service availability

In unadjusted analyses, invasive cardiac procedure use was much more frequent when the first hospital was equipped to provide these procedures (Figure 1). After adjustment for potential confounding variables, odds of catheterization within 90 days of AMI were more than 2 times greater in catheterization-only hospitals and 3 to 4 times greater in PTCA/CABG hospitals than in hospitals with no invasive cardiac services (Table IV). Odds of revascularization were 1.3 times greater when first hospitals had catheterization-only services and more than 2.5 times greater when first hospitals had PTCA/CABG services than when they had no invasive services. Considering only those who had catheterization, revascularization was slightly less likely overall with first admission to catheterization-only hospitals, but slightly more likely with hospitals providing PTCA/CABG compared with no invasive cardiac services. The patterns of increased procedure use with increased service availability was especially evident for younger blacks.

Adjusted mortality rate

Death within 1 year after first hospitalization for AMI was not statistically significantly different for blacks than for whites after adjustment for age, sex, health insurance status (for those younger than age 65), anatomic location of primary infarct, comorbidity, and level of cardiac services available at first admission. Adjusted mortality rate ratios and 95% confidence limits for blacks compared with whites were 0.85 (0.66, 1.09) younger than age 65 and 1.03 (0.89, 1.19) aged 65 and older. No statistically significant interactions for 1-year mortality were found between level of invasive cardiac services at first hospitalization and race ($P > .10$).

Impact of service availability with PTCA and CABG as separate outcomes

In post hoc analyses, we investigated whether patterns related to service availability that were found for revascularization were consistent for each of the revascularization procedures. Racial differences in use of PTCA were evident regardless of services available for those younger than age 65; differences were greatest when no invasive cardiac services were available and diminished when catheterization-only and PTCA/CABG services were available (Figure 2, *top*). PTCA use in the older age group for blacks compared with whites showed no pattern in relation to service availability. The greatest racial difference in PTCA use occurred when catheterization-only services were available at first hospitalization and the least when PTCA/CABG services were available.

Use of CABG for blacks compared with whites was lower regardless of service availability in both age groups (Figure 2, *bottom*). Racial differences reached statistical significance when no invasive cardiac services and when PTCA/CABG were available for the younger than age 65 group and only when PTCA/CABG services were available in the 65 and older group.

After adjustment for covariates, the statistically significant interaction between race and service availability found for revascularization in patients younger than age 65 was also detected for PTCA use alone (Table V). Service availability was associated with higher PTCA use for all patients, but especially among younger blacks. This same pattern was not found for CABG use in patients younger than age 65 (Table V). CABG use was higher when services were available than when they were not to a similar extent for both racial groups.

As reported for revascularization in patients aged 65 years and older, there were no statistically significant interactions between race and service availability for PTCA use or for CABG use when considered as separate outcomes. For virtually all elderly patients, service availability was related to higher procedure use, although confidence intervals were wide.

Discussion

This study confirms the existence of substantial racial differences in use of invasive cardiac services. We found that blacks had 26% and 32% lower odds of cardiac catheterization use than whites for those younger than age 65 years and those 65 years and older, respectively, whereas other researchers reported lower catheterization use between 15% to 33%.[4,6,9,11-13,22,23] Adjusted odds of revascularization for blacks compared with whites were lower by more than 30% in this study, which also confirms previous reports.[1,8-10,13,14,22] Even considering only those patients younger than age 65 who had catheterization, the odds of PTCA/CABG use were 33% lower in blacks. In other studies, use of PTCA/CABG only among those who had catheterization was reported to be lower by 44% in elderly black Medicare beneficiaries in 1986-1988,[8] by 31% to 41% in black veterans from 1988-1990,[13] and by 44% for all minorities discharged from California hospitals in 1991.[24]

This study also substantiates previous research reporting that services at the hospital of first admission were strongly related to the likelihood of procedure use for all patients. In our study, for both races combined, the adjusted odds of catheterization were more than 2 times higher when the first hospitals had catheterization-only services and 3 to 4 times higher when the first hospitals had PTCA/CABG services compared with hospitals that had no invasive cardiac ser-

Table IV. Use of invasive cardiac procedures within 90 days after AMI in patients first admitted to hospitals providing invasive cardiac services compared with hospitals not providing invasive cardiac services

	Younger than 65 y	
	Adjusted odds ratio for catheterization only service	**Adjusted odds ratio for PTCA/CABG service**
90-Day catheterization		
All patients	2.72 (2.32, 3.21)*†	4.77 (4.00, 5.71)*†
Black	3.41 (2.08, 5.69)	4.92 (3.23, 7.64)
White	2.66 (2.24, 3.17)	4.86 (4.00, 5.94)
90-Day PTCA/CABG		
All patients	1.32 (1.14, 1.53)*†	2.73 (2.38, 3.14)*†
Black	2.29 (1.37, 3.83)	4.92 (3.22, 7.61)
White	1.26 (1.08, 1.46)	2.55 (2.20, 2.96)
90-Day PTCA/CABG only among patients with catheterization		
All patients	0.85 (0.72, 1.00)*†	1.38 (1.17, 1.61)*†
Black	1.50 (0.84, 2.66)	2.59 (1.60, 4.24)
White	0.80 (0.67, 0.95)	1.27 (1.07, 1.50)

Adjusted odds ratio is for race (if not stratified), age, sex, health insurance (if younger than age 65), anatomic location of primary infarct, and MIDAS comorbidity score with logistic regression. Maximum likelihood 95% confidence intervals are shown in parentheses. Patients first admitted to hospitals without invasive cardiac facilities were reference group. Interaction between race and type of service available: *$P < .0025$, †$P > .10$.

Table V. Post hoc analysis of individual revascularization procedures within 90 days after AMI in patients first admitted to hospitals providing invasive cardiac services compared with hospitals not providing invasive cardiac services

	Younger than 65 y	
	Adjusted odds ratio for catheterization only service	**Adjusted odds ratio for PTCA/CABG service**
90-Day PTCA		
All patients	1.31 (1.12, 1.54)*	2.44 (2.11, 2.84)*
Black	2.57 (1.38, 4.74)	7.12 (4.35, 11.99)
White	1.24 (1.05, 1.47)	2.18 (1.87, 2.55)
90-Day CABG		
All patients	1.24 (1.05, 1.47)†	2.18 (1.87, 2.55)†
Black	1.42 (0.69, 2.83)	1.31 (0.72, 2.37)
White	1.11 (0.90, 1.36)	1.59 (1.32, 1.92)

Adjusted odds ratio is for race (if not stratified), age, sex, health insurance (if younger than age 65), anatomic location of primary infarct, and MIDAS comorbidity score with logistic regression. Maximum likelihood 95% confidence intervals are shown in parentheses. Patients first admitted to hospitals without invasive cardiac facilities were reference group. Interaction between race and type of service available: *$P < .0025$, †$P > .10$.

vices. The use of PTCA/CABG within 90 days was also 1.3 times higher with catheterization-only services at first admission. Patients were more than 2.5 times more likely to undergo a revascularization procedure when the first hospital was equipped to perform PTCA/CABG than when there was no invasive cardiac services at the first hospital. In the MITI Project from the Seattle area, catheterization services available at first admission were shown to result in a 3.2 times higher use of catheterization compared with when no catheterization services were available.[16] Availability of catheterization-only services resulted in a 3.5-fold increase in use of catheterization for patients admitted with primary AMI to hospitals in New York in 1986, but no increased likelihood of angioplasty or surgery.[17] Availability of revascularization in the New York study resulted in 5.5, 6.9, and 2.5 times greater odds of angiography, PTCA, and CABG, respectively. The generalizability of the results of our study and of these other 2 studies is limited in its focus of one geographic region. New Jersey is the most densely populated state, with substantial urban and suburban areas and high concentrations of specialist physicians. Our results would be best compared with those from a similar region.

Ours is the first study to our knowledge that specifically examined availability of invasive cardiac services in relation to race and procedure use. Percentages of blacks who were first admitted to hospitals with invasive cardiac services available were actually higher than those for whites. Most hospitals with invasive cardiac services in New Jersey are located in inner cities, where larger proportions of blacks reside. Still, only about half

65 y and older	
Adjusted odds ratio for catheterization only service	**Adjusted odds ratio for PTCA/CABG service**
2.24 (1.99, 2.53)*†	3.87 (3.39, 4.42)*†
2.97 (1.71, 5.22)	6.81 (4.18, 11.33)
2.22 (1.96, 2.51)	3.71 (3.23, 4.27)
1.32 (1.15, 1.51)*†	2.92 (2.55, 3.35)*†
1.40 (0.72, 2.65)	2.97 (1.80, 4.94)
1.32 (1.14, 1.51)	2.92 (2.53, 3.37)
0.70 (0.59, 0.83)*†	1.21 (1.01, 1.43)*†
0.50 (0.21, 1.15)	0.75 (0.38, 1.45)
0.71 (0.60, 0.85)	1.25 (1.04, 1.49)

65 y and older	
Adjusted odds ratio for catheterization only service	**Adjusted odds ratio for PTCA/CABG service**
1.36 (1.14, 1.62)*†	2.52 (2.14, 2.98)†
0.53 (0.17, 1.36)	2.75 (1.52, 5.05)
1.39 (1.16, 1.66)	2.50 (2.01, 2.98)
1.16 (0.97, 1.38)†	2.08 (1.76, 2.50)†
1.94 (0.88, 4.18)	2.02 (1.02, 4.04)
1.13 (0.94, 1.35)	2.15 (1.81, 2.55)

of all patients were first admitted to hospitals with catheterization-only services, whereas approximately half of those younger than age 65 and less than one third of those aged 65 and older to hospitals with PTCA/CABG services. Blacks whose first admissions were to hospitals having catheterization-only services were much more likely to have catheterization (roughly 3 times) and PTCA/CABG (2.3 times for those younger than 65 years and 1.4 for those 65 years and older) within 90 days after AMI than blacks whose first admissions were to hospitals having no invasive cardiac services. Although the trend for greater procedure use with higher level of availability at first hospitalization was evident for whites, these comparisons were not as striking among whites as blacks.

For those younger than age 65 in our study, availability of invasive cardiac services at first admission seemed to have an impact on racial differences in revascularization. The smallest racial differences in PTCA/CABG use within 90 days of AMI occurred when most services were available at first admission; the greatest racial differences were found when no invasive cardiac services were available. Therefore it seems possible that some of the racial disparities in procedure use after AMI might diminish if availability of invasive cardiac services were increased.

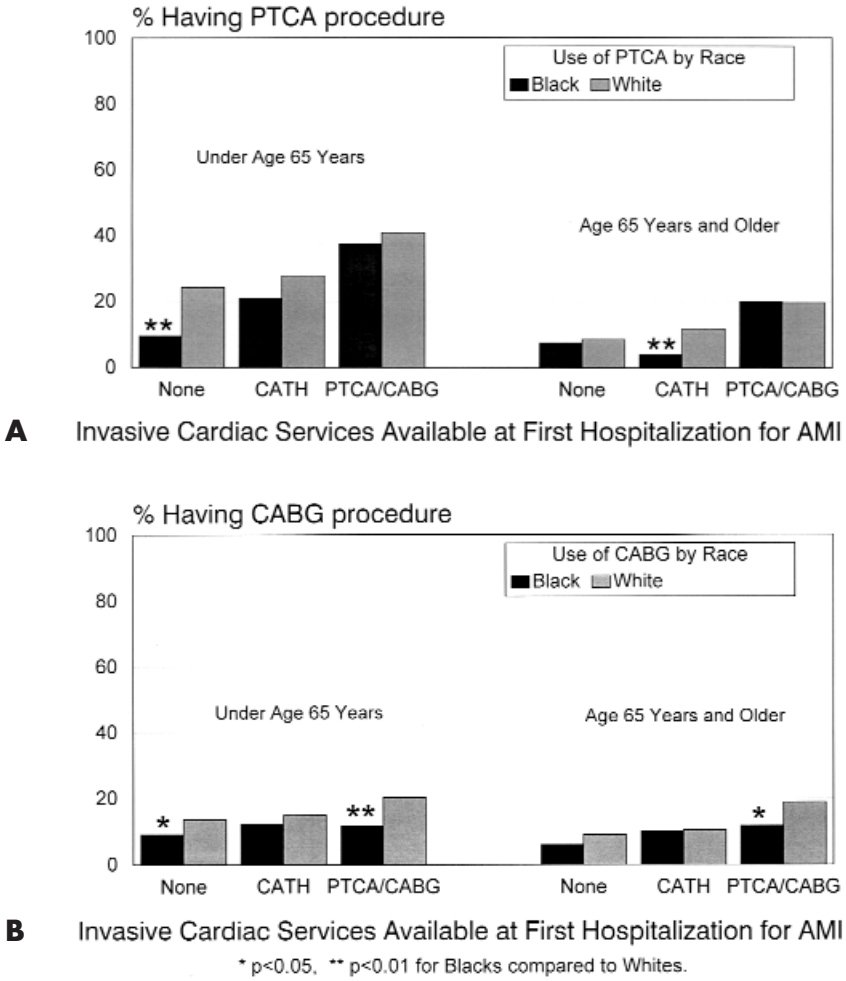
Although results are controlled for differences in health insurance status, the fact that availability of services reduced racial differences in those younger than age 65 and not in those aged 65 and older deserves further attention in studies with sufficient numbers of all health insurance groups younger than age 65. In post hoc analyses of revascularization procedures as separate outcomes, this pattern of significant impact of service availability on racial differences in the younger than age 65 group was evident for PTCA use but not for CABG use. Differences in patient perceptions, physician referrals, financial incentives, and disease patterns between PTCA use and CABG use could have resulted in this relation, which should be confirmed with additional studies of larger patient cohorts to obtain greater numbers of CABG procedures.

We would have expected that among those first admitted to hospitals with catheterization and revascularization services available, there would be few or no racial differences in procedure use. Instead, for those aged 65 and older, we found that racial discrepancies in use of catheterization and revascularization persisted despite availability of cardiac services at first admission. In a study of Los Angeles County hospital discharges, exclusion of discharges from hospitals without invasive cardiac services did not influence the black/white differences in use of catheterization, angioplasty, or surgery.[6] Likewise, when revascularization among those who had catheterization was studied in Medicare patients, no effects were observed on the racial disparities in 90-day PTCA/CABG use according to the level of cardiac services available at the hospital in which the catheterization took place.[8] Potential reasons for these racial disparities, even when invasive services were available, such as differences in physician referral patterns, patient preferences, physician-patient communication, and racial bias could not be explored with the data available for this study.

Overuse of invasive cardiac services in whites represents another potential explanation to the racial differences persisting even when services were available. Studies on appropriateness of care have shown many invasive cardiac procedures were done without proper indication.[25-27] It is possible that some racial disparities in invasive service use would dissipate merely by eliminating inappropriate procedure use.

Although equity in the distribution of invasive cardiac

Figure 2



Use of PTCA and CABG according to invasive cardiac services available at first hospitalization for AMI. *None,* No invasive cardiac services available; *CATH,* cardiac catheterization only. *$P < .05$, **$P < .01$ for blacks compared with whites.

services among racial/ethnic groups is important, optimal outcome after AMI is the ultimate goal. Despite the racial disparities in invasive cardiac procedure use, no differences were detected in 1-year mortality between blacks and whites who were hospitalized for AMI. Although it is possible that the number of patients monitored was not sufficient to show statistically significant differences, other researchers have also reported similar mortality rates by race.[1,13,23,28] Some studies of patients with symptomatic cardiovascular disease, however, have found higher long-term mortality rates among blacks.[29-31] It is plausible that patient outcomes other than death might have been different for blacks than for whites. Information on outcomes such as quality of life and functional status was not available for this study.

In conclusion, we have documented lower use of invasive cardiac procedures among blacks than among whites. Availability of invasive cardiac services at first admission after AMI was associated with substantially increased use of invasive cardiac procedures for both races. Although racial disparities were reduced to some degree with availability of invasive cardiac services at first hospitalization, especially among younger patients, differences between blacks and whites generally persisted even when services were available and adjustment was made for other measurable factors. Despite the racial disparities in procedure use, long-term mortality rate after AMI was not different for blacks than whites. Although availability of invasive cardiac services might play some part in the relation between patient race and use of invasive cardiac procedures, other factors also need to be explored to improve minority access to these services.

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