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Use of Cardiovascular Procedures among Black Persons and White Persons: A 7-Year Nationwide Study in Patients with Renal Disease

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Background: Black persons historically undergo fewer invasive cardiovascular procedures than white persons.

Objective: To determine whether acquisition of Medicare health insurance and comprehensive care for severe illness reduce ethnic disparity in use of cardiovascular procedures.

Design: 7-year longitudinal analyses in a cohort from the United States Renal Data System.

Setting: Health care institutions in the United States.

Patients: Nationwide random sample of 4987 adult black and white patients with incident end-stage renal disease (ESRD) from 303 dialysis facilities in 1986 to 1987.

Measurements: Medical history and service use records, physical examination, and laboratory data. Main outcome measures were receipt of a coronary catheterization or revascularization procedure before (baseline) and after (follow-up) development of ESRD and acquisition of Medicare, adjusted for clinical and socioeconomic variables.

Results: At baseline, 9.9% of white patients and 2.8% of black patients had had a cardiac procedure; the odds were almost three times greater in white than in black patients (adjusted odds ratio, 2.92 [95% CI, 2.04 to 4.18]). During follow-up, white patients were only 1.4 times more likely than black patients to have a procedure (adjusted relative risk, 1.41 [CI, 1.13 to 1.77]); rates were 7.8% for white persons and 8.5% for black persons. In patients with Medicare coverage before development of ESRD, the initial threefold difference in procedure use was eliminated over follow-up (odds ratio, 1.05 [CI, 0.56 to 1.60]). For procedures after hospital admission for myocardial infarction or coronary disease, no difference between ethnic groups was seen during follow-up (relative risk, 1.12 [CI, 0.68 to 1.85]).

Conclusions: Differences between ethnic groups in use of cardiovascular procedures narrowed markedly once a serious illness (ESRD) developed and adequate insurance coverage was ensured; the disparity was eliminated in patients with previous Medicare insurance or a stronger indication for a procedure. These findings suggest that almost equal access to care is attainable by combining insurance with delivery of comprehensive, clinically appropriate care.

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Coronary atherosclerotic disease remains the leading cause of death in the United States despite a considerable decrease in mortality rates since the 1980s (1). This decrease in the rate of death from ischemic heart disease is attributable in part to the now-established technologies of invasive cardiac procedures: cardiac catheterization, percutaneous transluminal coronary angioplasty, and coronary artery bypass grafting (2). Unfortunately, as with many health indicators and health services, improvements in both the mortality rate from coronary disease and rates of invasive cardiac procedures among black persons have lagged behind those of white persons (1, 3–10). Although previous work documented ethnic differences in use of cardiac procedures, the studies were limited by cross-sectional design, examination of a few selected practice settings, or exclusion of potentially confounding clinical and socioeconomic variables (11–24). Furthermore, previous research has not addressed whether or which factors can alter trends in use of cardiac procedures and thus narrow disparity among ethnic groups.

We hypothesized that the large variation in use of cardiac procedures between black persons and white persons would decrease with acquisition of adequate health insurance when this occurs in conjunction with development of a serious illness. In-

See related article on pp 183-192 and editorial comment on pp 231-233.

creased use of cardiac procedures among black persons may follow attainment of health insurance or establishment of a regular source of medical care. Once serious illness occurs, avoidance of discretionary procedures because of increased risk for complications may lead to a relative decrease in use of procedures among white persons, especially if procedures were previously overused. End-stage renal disease (ESRD) is a significant illness in which patients are at high risk for cardiovascular disease; patients with ESRD almost always acquire Medicare health insurance and enter a comprehensive system of care. Cross-sectional research suggests that access to dialysis and physician visits improved after enactment of the Medicare program (25, 26). We used the progression of patients from chronic renal failure to ESRD as a natural experiment to examine whether ethnic differences in use of cardiovascular procedures narrow with initiation of long-term dialysis and coincident acquisition of insurance.

Methods

Study Design and Patients

We performed a national longitudinal cohort study in patients with chronic renal failure and ascertained use of cardiovascular procedures before (baseline) and after (follow-up) development of ESRD. To be eligible for inclusion in the study, patients had to have new-onset ESRD in 1986 or 1987, be either black or white, and be at least 18 years of age. We followed patients for up to 7 years: until death, renal transplantation, or the end of the study on 31 December 1992.

Data Collection

We used data from the Case Mix Severity Study of the United States Renal Data System (USRDS). The USRDS is a national research organization created and funded by the National Institutes of Health to assemble information on ESRD incidence, prevalence, treatment, morbidity, and mortality. The primary purpose of the Case Mix Severity Study, conducted from 1989 to 1991, was to provide prevalence data on the frequency of various comorbid conditions that commonly occur in ESRD. The Case Mix Severity Study used a two-stage random sampling method of patients and dialysis units to obtain a 5% national random sample of patients with incident ESRD in 1986 to 1987 (27).

Abstracters reviewed medical charts in dialysis units to identify patients' clinical and socioeconomic status by using a standardized instrument that recorded information obtained shortly before development of ESRD and initiation of dialysis. Variables included information about health insurance, education, marital status, employment status, type of employment, medical history of coronary disease, coronary risk factors, comorbid conditions, and physical examination and laboratory data. Data on medical evidence of ESRD, as part of the USRDS, provided baseline sociodemographic information on date of birth, sex, ethnic group, and date of ESRD onset.

For data sources in the 7-year follow-up period after the onset of ESRD, we used Medicare hospitalization records that provided the date of admission, date of discharge, and procedure and diagnosis codes for each hospitalization. Medicare registry data provided the dates of renal transplant or death. Consequently, we could identify patient admissions at any acute care hospital in the United States over the course of the study and link medical record abstraction data to Medicare registry and hospitalization files. Medicare hospitalization and registry data were assembled 3 years after the end of follow-up to provide complete records.

Outcome Measures

For receipt of a cardiac procedure before onset of ESRD, we used evidence of cardiac catheterization, angioplasty, or coronary artery bypass grafting from medical record abstraction. For longitudinal outcomes after the onset of ESRD and initiation of dialysis, we used the first evidence of these cardiac procedures from hospitalization records. The following codes from the International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM], were used: for cardiac catheterization, codes 37.21, 37.23, and 88.57 to 88.59; for angioplasty, codes 36.01, 36.02 and 36.05; and for coronary artery bypass grafting, codes 36.10 to 36.19 (28). In the primary longitudinal analysis, we did not examine patients who had already undergone a cardiac procedure at baseline because, by definition, they had already had access to a procedure. These patients were included in sensitivity analyses. For both baseline and follow-up analyses, we also separately examined receipt of diagnostic procedures (cardiac catheterization) and therapeutic procedures (angioplasty and coronary artery bypass grafting). Furthermore, as a follow-up outcome, we examined the specific case of receipt of a cardiac procedure within 90 days after admission for a primary diagnosis of coronary artery disease (ICD-9-CM codes 411.1, 411.81, 411.89, 410, 413, and 414) or acute myocardial infarction (ICD-9-CM codes 410.x) as a proxy measure of clinical appropriateness (12, 13, 29).

Statistical Analyses

Primary Analysis

We performed bivariate analyses with the chi-square and Student *t*-tests to investigate differences

in baseline socioeconomic and clinical characteristics between black persons and white persons and to examine the relations between individual clinical and socioeconomic characteristics and the outcomes of receipt of a cardiac procedure at baseline and at follow-up.

We then developed a logistic regression model to examine whether receipt of a cardiovascular procedure at baseline varied by ethnic group while adjusting for explanatory or potentially confounding socioeconomic and clinical variables. We constructed the model with covariates that were significantly associated with receipt of a cardiac procedure in bivariate analyses or variables that were deemed clinically relevant for the analyses. Our explanatory demographic and socioeconomic variables were age, ethnic group, sex, type of health insurance at baseline (private, Medicaid, Medicare, or no insurance), education (high school graduate), type of employment (white collar, blue collar, or other), employment status (employed, retired or disabled, or unemployed), marital status (single, married, or previously married), and region of the United States (northeast, southeast, midwest, west, or southwest). Clinical variables were coronary artery disease (history of myocardial infarction or angina), hypertension (Fifth Joint National Committee on Hypertension criteria for hypertension steps 1 and above or history of hypertension), history of smoking, elevated cholesterol level (>5.2 mmol/L [>200 mg/dL]), elevated triglyceride level (>2.8 mmol/L [>2.5 g/L]), diabetes mellitus (history of diabetes or receiving medication for diabetes), obesity (body mass index > 27.8 kg/m^2 for men and > 27.3 kg/m^2 for women or nutritional status described as obese), cerebrovascular disease (history of stroke), congestive heart failure (history of congestive heart failure), history of a malignant condition, low serum albumin level (<30 g/L), and type of dialysis (hemodialysis or peritoneal dialysis) (30).

To identify receipt of a cardiovascular procedure during follow-up, we constructed a similar logistic regression model. In this model, we included adjustment for the number of days at risk for having a cardiac procedure, because black persons who receive dialysis live longer than white persons who undergo this treatment (31–33). We also performed stratified subgroup analyses by year of follow-up and by insurance status at baseline; in these analyses, we modified the models to include key but fewer variables because of the smaller number of patients in each stratum. Adding variables to these models in separate analyses did not appreciably change the point estimates.

Finally, we developed a Cox proportional hazards model to examine time to receipt of a cardiovascular procedure during follow-up for white persons compared with black persons. In addition to the explanatory variables in the other models, we included time-dependent covariates for specific comorbid diseases during follow-up in this model so that we could account not only for baseline conditions but also for conditions that may have developed after the onset of ESRD and could have decreased or increased the likelihood of an invasive cardiac procedure.

For time-dependent covariates, we used evidence of hospital admission for cerebrovascular disease (ICD-9-CM codes 430 to 438), malignant conditions (ICD-9-CM codes 140 to 172.9, 174 to 195.8, 196 to 199.1, and 200 to 208.9), and peripheral vascular disease (ICD-9-CM codes 440.2, 443.8 to 444.0, and 444.22 to 444.81). We also examined the occurrence of admission of patients with dementia (ICD-9-CM codes 290 to 290.9), chronic obstructive pulmonary disease (ICD-9-CM codes 490 to 494, 496, 500 to 505, and 506.4), and moderate to severe liver disease (ICD-9-CM codes 572.2 to 572.8); these variables had no statistically significant effect on the receipt of follow-up procedures in our bivariate analyses and thus were not included in the Cox model (34, 35).

Sensitivity Analyses

To examine the robustness of the results, we performed several sensitivity analyses. We first performed longitudinal analyses for use of cardiovascular procedures during follow-up without excluding patients who underwent procedures at baseline. In addition to examining use of cardiovascular procedures at baseline for the entire cohort, we separately investigated outcomes for the subgroup of patients who had medical record evidence of coronary disease before dialysis was initiated. We also performed analyses for use of procedures during follow-up for a coronary disease group consisting of patients with coronary disease at baseline who did not undergo a procedure and those with a hospital admission for coronary disease during follow-up. The magnitudes of the odds ratios and relative risks for white persons compared with black persons from these sensitivity analyses were essentially equal to the results of our primary analyses.

Data on ethnic group, sex, age, and geographic region were available for all participants. However, data were missing on at least 1 of the 18 remaining covariates for most of the study patients (80%); this is not unusual with chart abstraction data of this magnitude. By using logistic regression and Cox models, we analyzed the data with different techniques for handling missing covariates. We first determined which variables were likely to be important confounders in our analysis; because the number of

Table 1. Baseline Demographic and Socioeconomic Characteristics in a Cohort of 4987 Patients*

Characteristic	White Patients (n = 3152)	Black Patients (n = 1835)
Demographic		
Mean age, *y*	60.8	56.1
Men, %	53.8	49.8
Region of United States, %		
Northeast	35.3	39.5
Southeast	16.8	25.5
Midwest	24.0	16.6
Southwest	12.1	9.9
West	11.8	8.5
Socioeconomic†		
Type of health insurance, %		
Private	67.1	44.3
Medicare	22.9	31.9
Medicaid	5.6	12.1
Uninsured	4.3	10.8
Marital status, %		
Married	59.1	40.7
Previously married	29.2	40.7
Single, never married	11.7	19.2
Level of education, %		
Not high school graduate	34.8	53.1
High school graduate	36.2	29.3
Some college	14.5	10.7
College graduate	14.6	6.7
Employment status, %		
Employed	25.7	33.1
Retired or disabled	57.3	44.9
Unemployed	4.3	12.2
Type of employment, %		
White collar job	25.1	13.5
Blue collar job or other	74.8	85.5

* All differences between black patients and white patients were statistically significant at $P < 0.01$ except for the percentage of patients in the southwestern United States, which was significant at $P < 0.05$.

† Percentages reflect patients with data available for the following variables: health insurance, 2964 white patients and 1719 black patients; marital status, 2976 white patients and 1707 black patients; level of education, 1844 white patients and 1165 black patients; employment status, 2649 white patients and 1499 black patients; type of employment, 2407 white patients and 1398 black patients.

confounders was limited, missing data became less of a concern. We then constructed regression models using only patients for whom data on these major confounders was complete (36). In addition, we constructed models in which we adjusted for the other covariates by using imputed data for missing variables (37). Finally, we used a method (previously used by the USRDS) in which we included specific dummy variables in the regression models for instances when data were missing (27, 38). All methods used to address missing data yielded essentially identical results.

We also examined the effect of patient clustering in different dialysis facilities. A generalized estimating equation model showed the correlation in procedure use with dialysis facilities to be negligible ($r = 0.008$). Conditional logistic regression analyses yielded results that were similar to those found with ordinary logistic regression; this indicates that little confounding of the relation between ethnic group and procedure use by dialysis facility was present (39). All analyses were performed by using SAS software, version 6.11 (SAS Institute, Cary, North Carolina).

Results

Patients

Of 5255 patients in the initial Case Mix Severity Study, we excluded 186 who were not known to be either black or white, 71 who were younger than 18 years of age, and 11 who did not have incident ESRD in 1986 to 1987. Thus, 4987 patients met our inclusion criteria and were enrolled in the study.

In our study, 3152 white patients and 1835 black patients were distributed among 303 dialysis facilities. The median number of patients per facility was 11 (range, 1 to 130). White patients were older than black patients by a mean of 4 years; this reflects the earlier onset of ESRD among black patients (**Table 1**) (33). For almost all indicators of socioeconomic status, measures for black persons were lower than those for white persons. Compared with black patients, white patients were more likely to be high school graduates, were 50% more likely to have private health insurance, and were almost twice as likely to hold white collar jobs. Compared with white patients, black patients were more than twice as likely to have Medicaid coverage or to be uninsured, were more likely to be single and never married, and were almost three times more likely to be unemployed.

Cardiac risk factors and disease were very prevalent in our study sample. White patients were more likely than black patients to have coronary artery disease at baseline (**Table 2**). Black patients were more likely than white patients to be obese. Hypercholesterolemia was common in both groups; black patients were more likely to have a total cholesterol level of more than 5.2 mmol/L. Consistent with the etiology and pathophysiology of ESRD, hypertension and diabetes were highly prevalent in both groups; black patients were more likely than white patients to have hypertension. Peripheral vascular disease and cerebrovascular disease also affected a substantial proportion of patients in both ethnic groups in this sample of persons at high risk for atherosclerosis. White patients were more likely than black patients to have a malignant condition and were more likely to undergo peritoneal dialysis.

Use of Cardiac Procedures at Baseline

Examination of cardiac procedures at baseline (before development of ESRD and initiation of renal replacement therapy) revealed large differences between black patients and white patients (**Table 3**). Absolute rates for use of procedures were 9.9% among white patients and 2.8% among black patients. The odds of undergoing any cardiac procedure—cardiac catheterization, angioplasty, or coronary artery bypass grafting—were almost four times greater among white patients than among black pa-

Table 2. Baseline Clinical Characteristics of a Cohort of 4987 Patients*

Characteristic	White Patients (n = 3152)	Black Patients (n = 1835)
	%	
Dialysis method		
Hemodialysis	78.3	86.0
Peritoneal dialysis	21.7	14.0
Medical history		
Coronary artery disease	47.0	41.6
Hypertension	87.9	95.5
Diabetes mellitus	42.0	44.7
Smoking	48.9	43.6
Obesity	29.0	38.9
Congestive heart failure	46.5	48.4
Peripheral vascular disease	24.4	21.2
Cerebrovascular disease	11.4	11.8
Malignant condition	12.6	6.3
Laboratory data		
Serum cholesterol level >5.2 mmol/L	40.0	47.7
Serum triglyceride level >2.5 g/L	30.0	19.9
Serum albumin level <30 g/L	15.1	16.2

* Differences between black patients and white patients were significant at $P < 0.01$ except for peripheral vascular disease, which was significant at $P < 0.05$, and diabetes mellitus, congestive heart failure, cerebrovascular disease, and serum albumin level, which did not differ significantly at $P < 0.05$. Percentages reflect patients with data available for the following variables: dialysis method, 3133 white patients and 1831 black patients; coronary artery disease, 2881 white patients and 1624 black patients; hypertension, 3094 white patients and 1811 black patients; diabetes mellitus, 2992 white patients and 1744 black patients; smoking, 2107 white patients and 1182 black patients; obesity, 2156 white patients and 1261 black patients; congestive heart failure, 2750 white patients and 1555 black patients; peripheral vascular disease, 2800 white patients and 1583 black patients; cerebrovascular disease, 2736 white patients and 1556 black patients; malignant conditions, 2726 white patients and 1525 black patients; serum cholesterol level, 2217 white patients and 1255 black patients; serum triglyceride level, 1636 white patients and 839 black patients; serum albumin level, 2760 white patients and 1538 black patients.

tients. After adjustment in logistic regression for socioeconomic and clinical variables, the odds of undergoing a cardiac procedure were still almost three times greater among white patients than among black patients. This was true in a partially adjusted model and in a fully adjusted model with imputed covariates for missing data. Major covariates contributing to the change in the ethnic group coefficient included insurance coverage and marital status. The adjusted odds of undergoing diagnostic cardiac catheterization were more than 2.5 times greater among white patients than among black patients, and the adjusted odds of receiving a therapeutic procedure (angioplasty or coronary artery bypass grafting) were more than three times greater among white patients than among black patients.

The rates of cardiac procedures among patients with medical record evidence of coronary artery disease at baseline were 22.4% for white patients and 7.4% for black patients. In this subgroup, odds ratios for the receipt of any procedure at baseline for white persons compared with black persons were similar to the results for the entire cohort (unadjusted odds ratio, 3.59 [95% CI, 2.59 to 4.98]; adjusted odds ratio, 2.80 [CI, 2.00 to 3.92]).

Use of Cardiac Procedures at Follow-up

We examined use of cardiovascular procedures over 7 years of follow-up (after development of ESRD and possession of Medicare insurance in the entire cohort). The unadjusted prevalence rates in follow-up for receipt of any procedure were 7.8% for white patients and 8.5% for black patients (**Table 4**). Black patients who receive dialysis, however, survive longer than white patients who undergo this treatment: In 1987, black patients with incident ESRD survived approximately 12 months longer than white patients (31–33). Thus, consideration of time at risk for a procedure is important. When we adjusted for time at risk for a procedure, white patients had 35 procedures per 1000 person-years at risk and black patients had 26 procedures per 1000 person-years at risk. The follow-up procedure rates for a subgroup of patients with coronary disease were 14.4% for white patients and 15.5% for black patients; white patients underwent 67 procedures per 1000 person-years at risk and black patients underwent 48 procedures per 1000 person-years at risk.

In the Cox proportional hazards model for the receipt of any cardiac procedure during follow-up, the relative risk was 1.4 times that among white patients than among black patients (**Table 4**). For diagnostic cardiac catheterization, the relative risk among white patients compared with black patients was also 1.4. White patients were almost twice as

Table 3. Use of Cardiovascular Procedures before Development of End-Stage Renal Disease (Baseline)

Procedure	All Patients (n = 4987)	White Patients (n = 3152)	Black Patients (n = 1835)	Difference in Percentages of White and Black Patients	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)	
						Partial Model*	Full Model†
	← % →			*percentage points*			
Cardiac catheterization, angioplasty, or coronary artery bypass grafting	7.3	9.9	2.8	7.1	3.84 (2.86–5.26)	2.88 (2.08–4.08)	2.92 (2.04–4.18)
Cardiac catheterization	4.2	5.5	1.9	3.6	3.06 (2.08–4.52)	2.52 (1.71–3.72)	2.62 (1.67–4.10)
Coronary artery bypass grafting	4.3	6.0	1.4	4.6	4.55 (2.94–7.14)	3.30 (2.14–5.08)	2.97 (1.88–4.67)
Coronary artery bypass grafting or angioplasty	4.8	6.7	1.5	5.2	4.63 (3.06–7.05)	3.38 (2.24–5.10)	3.13 (2.03–4.83)

* Adjusted for age, sex, geographic region, type of health insurance, and marital status; for 4457 patients with complete data.
† Adjusted for age, sex, level of education, type of health insurance, geographic region, dialysis type, type of employment, marital status, coronary artery disease, coronary risk factors, and comorbid conditions.

Table 4. Use of Cardiovascular Procedures after Development of End-Stage Renal Disease (Follow-up)

Procedure	Crude Rate		Rate per 1000 Person-Years		Crude Relative Risk (95% CI)	Adjusted Relative Risk (95% CI)*
	White Patients (n = 2839)	Black Patients (n = 1784)	White Patients (n = 2839)	Black Patients (n = 1784)		
	%					
Cardiac catheterization, angioplasty, or coronary artery bypass grafting	7.8	8.5	35.0	26.0	1.36 (1.11–1.68)	1.41 (1.13–1.77)
Cardiac catheterization	7.3	8.1	33.0	25.0	1.33 (1.07–1.64)	1.40 (1.11–1.77)
Coronary artery bypass grafting	1.6	1.2	7.3	3.6	2.08 (1.24–3.50)	1.80 (1.02–3.16)
Angioplasty	1.3	1.1	5.9	3.3	1.96 (1.13–3.41)	2.10 (1.17–3.76)
Coronary artery bypass grafting or angioplasty	2.6	2.1	12.0	6.0	1.95 (1.31–2.89)	1.83 (1.19–2.82)
Any of these procedures within 90 days of hospital admission for acute myocardial infarction or coronary artery disease†	32.8	33.3	–	–	1.00 (0.75–1.35)	1.12 (0.68–1.85)

* Adjusted for age, sex, education, type of health insurance, geographic region, dialysis type, type of employment, marital status, coronary artery disease, coronary risk factors, comorbid conditions at baseline, and comorbid conditions at follow-up. For angioplasty, relative risk is adjusted for age, sex, type of health insurance, coronary artery disease, smoking, cholesterol level, congestive heart failure at baseline, and comorbid conditions at follow-up.
† n = 364 for white patients; n = 210 for black patients.

likely as black patients to undergo therapeutic angioplasty or coronary artery bypass grafting during follow-up. The results of the logistic regression models constructed for follow-up were consistent with those of the Cox models, but the point estimates were slightly lower.

During follow-up, 564 patients had primary admissions for coronary artery disease or myocardial infarction. Of note, for follow-up cardiac procedures within 90 days of a primary admission for acute myocardial infarction or coronary artery disease, no difference was seen between ethnic groups (relative risk, 1.12 [CI, 0.68 to 1.85]) (**Table 4**).

Because of the wide baseline disparity in outcomes between ethnic groups and the narrowing of this gap at 7 years of follow-up, we investigated how the odds of undergoing a cardiac procedure changed over time (**Figure 1**). In the first year after development of ESRD, the odds ratio of a procedure for white patients compared with black patients decreased from 3.3 to 1.3. By the second year, the odds ratio was essentially 1.0. In later years, black patients seemed to be more likely than white patients to undergo a cardiac procedure, but this difference was not statistically significant.

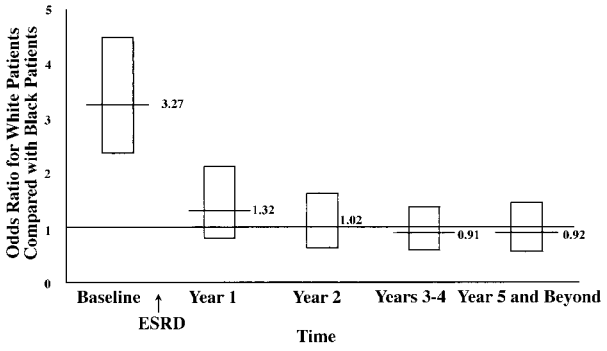

Figure 1. Adjusted odds ratio of receiving a cardiovascular procedure (cardiac catheterization, angioplasty, or coronary artery bypass grafting) over time among white patients and black patients. The odds ratios are derived from a logistic regression model that included the following covariates: age, sex, health insurance status at baseline, coronary artery disease at baseline, cholesterol level, history of smoking, presence of a malignant condition, and days at risk for a procedure. The heights of the bars represent the 95% CIs for the odds ratios; the horizontal lines represent the point estimates.

Effect of Insurance Status

We examined the relation between type of health insurance at baseline and use of procedures at either baseline or follow-up (**Figure 2**). Among patients who had private insurance at baseline, the odds of undergoing a procedure at baseline (before onset of ESRD) were 3.6 times greater among white patients than among black patients; at follow-up (after onset of ESRD), the odds of undergoing a procedure were 1.6 times greater among white patients than among black patients. For the subgroup of patients who already had Medicare insurance at baseline, the adjusted odds ratio of procedure use for white patients compared with black patients was 3.0 at baseline; at follow-up, however, with no change in insurance status, the odds of receipt of a procedure for black patients and white patients were the same. In the subgroup of patients with Medicaid insurance at baseline, the adjusted odds ratio of 1.6 for procedure use in white patients compared with black patients did not change appreciably over time. In the subgroup of uninsured patients, black patients tended to be more likely to undergo a cardiac procedure than white patients at follow-up; this contrasts with the large disparity between ethnic groups seen at baseline.

Discussion

In our large nationwide longitudinal study, we used the high prevalence of cardiovascular disease in patients with renal disease and universal acquisi-

tion of insurance and regular medical care as long-term dialysis was initiated to explore disparity between two ethnic groups in access to these procedures. Initially, a threefold difference was seen between black patients and white patients in the odds of undergoing a cardiac procedure, even after we controlled for clinical and socioeconomic variables that could affect the relation between ethnic group and use of cardiovascular procedures. This disparity is similar to or greater than that identified in most previous studies in the general population (11–13, 15, 18, 22, 24). The ethnic differences appreciably narrowed overall for both diagnostic and therapeutic procedures after development of a severe illness (ESRD), acquisition of Medicare coverage, and acquisition of a regular source of health care; this result may reflect clinical needs that were previously unmet. Almost all of the decrease occurred within the first 2 years after development of ESRD. In fact, in the subgroups of patients who had Medicare insurance at baseline or primary admissions for myocardial infarction or coronary artery disease, the differences between black patients and white patients disappeared completely.

A main contributor to the narrowing of the disparity between ethnic groups seems to be a higher prevalence of procedures for black patients at follow-up (8.5%) than at baseline (2.8%). We contemplated whether acquisition of health insurance through Medicare, which enables patients to afford expensive technologies, was primarily responsible for the increased receipt of procedures among black patients. The importance of insurance coverage, long considered a cornerstone of access to medical care, for obtaining care has been well documented (40–44). The larger baseline disparity in procedures between uninsured patients and those with Medicaid, Medicare, or private insurance supports this hypothesis, although the subgroup of uninsured patients made up only a small percentage of the study cohort. A substantial baseline disparity between black patients and white patients, however, exists in the privately insured and Medicare subgroups, providing evidence against acquisition of health insurance as the only factor in narrowing the ethnic gap.

Previous studies have observed the importance of a regular source of care in access to medical care (45–47). End-stage renal disease entails not only Medicare insurance coverage for a fairly comprehensive set of medical services but also rigorous medical follow-up. Once patients with chronic renal disease undergo dialysis, most can presumably identify a regular medical provider or team of providers if not a single primary physician. Because the patient's life depends on compliance with dialysis, follow-up with this comprehensive system is likely to be greatly enhanced. Our data suggest that independent of or through interaction with insurance status, access to this health system plays a role in increasing receipt of cardiovascular procedures among black patients. The subgroup of patients with Medicare coverage at baseline had no change in insurance type once they received care for ESRD, but the gap between ethnic groups for cardiovascular procedures was completely closed after initiation of comprehensive care for ESRD.

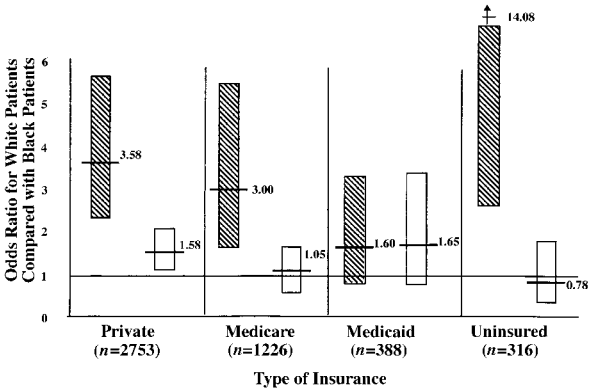

Figure 2. Disparity in use of cardiovascular procedures (cardiac catheterization, angioplasty, or coronary artery bypass grafting) by type of health insurance at baseline over time among white patients and black patients. The odds ratios are derived from a logistic regression model that included the following covariates: age, sex, presence of coronary artery disease at baseline, presence of a malignant condition, and days at risk for a procedure. The striped bars represent odds ratios (point estimates and 95% CIs) at baseline; the white bars represent odds ratios at follow-up.

Another factor potentially responsible for decreasing the disparity between ethnic groups in use of cardiovascular procedures is a reduction in the use of discretionary procedures by white patients once they have a serious illness and are at higher risk for procedure-related complications. The slightly lower overall procedure rate in white patients (7.8% at follow-up compared with 9.9% at baseline) and their substantially lower rate of revascularization procedures at follow-up (2.6%) compared with baseline (5.2%) are consistent with this hypothesis, especially given the increase in procedure rates seen among black patients. This difference persists even when patients who had cardiac procedures at baseline are included in the follow-up analysis. These findings suggest that white patients may have initially undergone some unnecessary procedures. Several other studies have documented a higher rate of discretionary procedure use in populations that are better insured (48–52). Extrapolation of the study results to the 66 000 patients undergoing incident dialysis in the United States in 1986 and 1987 shows that use of cardiovascular procedures after initiation of dialysis and receipt of Medicare insurance would have increased from approximately 600 to 1800 procedures among black patients and would have de-

creased from about 4300 to 3100 among white patients.

When we examined the specific case of a follow-up cardiac procedure within 90 days of a primary admission for coronary artery disease or myocardial infarction, we found no difference between black patients and white patients in the likelihood of receipt of a procedure. Use of cardiac catheterization, angioplasty, or coronary artery bypass grafting within 90 days of hospital admission for a coronary condition is one proxy for appropriateness of procedure use (12, 13). If use of procedures in these circumstances is less discretionary and more clinically indicated than use of procedures in any circumstance, then it is reasonable that differences between black patients and white patients could be eliminated. It is possible that a difference was present in this subgroup that we could not detect because the statistical power was lower than that for the overall analyses; however, with the high burden of coronary disease and event rate in the study cohort, this would be unlikely. If there truly is no difference between ethnic groups, this finding is important: It suggests that when patients have adequate health insurance, a regular source of care, and a strong clinical indication for a cardiac procedure, equity in use of services between black patients and white patients can be achieved.

The interplay of factors responsible for closing the ethnic gap is complex. Several elements probably contribute to the observed decrease in disparity between ethnic groups in use of cardiovascular procedures. This explanation is consistent with conceptual models of access to care that describe multiple alterable factors that influence access to care, including health insurance coverage, a regular source of care, and conditions related to clinical need (40, 53, 54).

Our study has several limitations. First, although we controlled for history of and major risk factors for ischemic heart disease, we had no angiographic data on patients. Thus, we were unable to determine more precisely whether angioplasty or coronary bypass surgery was indicated after diagnostic cardiac catheterization. Given that the ethnic discrepancy in rates of therapeutic procedures was large, it is doubtful that ethnic differences in rates of angiographic disease alone would be sufficient to account for our findings. Another limitation in this study was the lack of information on the treating hospital (specifically, the availability of these invasive procedures) and the distance from the patients' homes to the hospital. However, previous work has shown that ethnic differences persist across different types of hospitals, even when invasive procedures are available (55).

In addition, our outcome variables in follow-up were derived from national hospital discharge data, and although these data are often more comprehensive than chart reviews or patient interviews, they are subject to the inherent limitations of administrative records. The assembly of administrative records 3 years after completion of follow-up ensures a high likelihood of capturing events of interest. If some outcomes were missed or misclassified at baseline and during follow-up, there should be no difference between black patients and white patients; this nondifferential misclassification would have little effect on our conclusions.

Another limitation is that we do not have information on patient preferences. Both patient preferences and patient–physician communication may differ by ethnic group (56–58). We do not know how patient acceptance of offered or recommended cardiac procedures may change according to ethnic groups after acquisition of insurance or development of a serious illness. We also do not know which physician or groups of physicians recommended invasive procedures. Other research has suggested that most nephrologists are involved in both primary care and management of cardiovascular disease for their dialysis patients (59). Thus, we presume that nephrologists would have been likely to play an important role in discussions about invasive procedures. Finally, studying patients with ESRD allowed close examination of a sample with a serious, chronic disease; our findings may not be generalizable to healthier persons.

Notwithstanding these limitations, we have shown that after accounting for potential confounding clinical and socioeconomic variables, the threefold ethnic differences in use of cardiac catheterization, angioplasty, and coronary artery bypass grafting seen at baseline narrowed markedly after patients developed a serious illness, received Medicare insurance, and entered a comprehensive system of medical care. For patients with Medicare insurance at baseline or a more selective coronary syndrome, the differences were completely eliminated. The results suggest that ethnic disparity in access to care can be decreased substantially when health system factors, such as adequate insurance and a regular source of care, and strong clinical indications for selection of patients for expensive procedures are in place. For the Medicare ESRD program, which costs $10 billion annually, the results provide some reassurance for decreasing ethnic disparity in diagnosis and treatment of coronary disease, a leading cause of illness and death among dialysis patients (33). Our results also suggest that for the general population, health insurance may be necessary but not sufficient to narrow ethnic gaps in access. Combining insurance with systems that deliver comprehensive, clin-

appropriate care should improve the attainment of equitable access to care.

Disclaimer: The data reported here have been supplied by the U.S. Renal Data System. The interpretation and reporting of these data are the responsibility of the authors and in no way should be seen as an official policy of or interpretation by the U.S. government.

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