# Underuse of Invasive Procedures Among Medicaid Patients With Acute Myocardial Infarction

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A B S T R A C T

*Objectives.* The purpose of this study was to determine whether underuse of cardiac procedures among Medicaid patients with acute myocardial infarction is explained by or is independent of fundamental differences in age, race, or sex distribution; income; coexistent illness; or location of care.

*Methods.* Administrative data from 226 hospitals in New York were examined for 11 579 individuals hospitalized with a primary diagnosis of acute myocardial infarction. Use of various cardiac procedures was compared among Medicaid patients and patients with other forms of insurance.

*Results.* Medicaid patients were older, were more frequently African American and female, and had lower median household incomes. They also had a higher prevalence of hypertension, diabetes, lung disease, renal disease, and peripheral vascular disease. After adjustment for these and other factors, Medicaid patients were less likely to undergo cardiac catheterization, percutaneous transluminal coronary angioplasty, and any revascularization procedure.

*Conclusions.* Factors other than age, race, sex, income, coexistent illness, and location of care account for lower use of invasive procedures among Medicaid patients. The influence of Medicaid insurance on medical practice and process of care deserves investigation. (*Am J Public Health.* 2001;91:1082–1088)

Because invasive cardiovascular procedures have been shown to benefit some individuals after acute myocardial infarction,[1–3] use of these procedures has been employed as a measure of overall intensity or quality of care across populations.[4–12] While hospital characteristics are important determinants of process, intensity, and quality of care,[7,11–16] studies also show that the elderly, minorities, women, and the economically disadvantaged are less likely to be treated aggressively or to undergo invasive cardiac procedures in the evaluation and treatment of coronary artery disease. In aggregate, these reports provide compelling evidence for prevalent physician or patient biases in the management of stable coronary artery disease and acute coronary syndromes.[5,8,10,12,13,17–26]

Likewise, patients with Medicaid insurance who are treated for acute myocardial infarction are less likely to undergo invasive procedures than those with other forms of insurance, suggesting that they receive a different, and perhaps inferior, process of care.[26] However, the Medicaid population differs from other insurance groups in terms of age, race, and sex mix; socioeconomic status (SES); and prevalence of coexistent illnesses.[17,25–28] In addition, Medicaid patients with cardiovascular diseases receive their care in hospitals with prevailing characteristics different from those of hospitals in other insurance groups.[11–13,17,26–28] Thus, lower rates of procedure use among Medicaid patients may be indicative of more global treatment practices or preferences determined by age, race, sex, SES, or hospital-to-hospital variation. Conversely, Medicaid insurance may be more than simply a proxy for demographic, clinical, and hospital factors, exerting its own independent influence on process of care.

The present study was performed to examine the association between Medicaid insurance, age, race, sex, coexistent illness, SES, and hospital characteristics and the use of invasive procedures among a cohort of consecutive unselected patients with acute myocardial infarction treated across a spectrum of clinical settings. We hypothesized that Medicaid insurance would affect process of care independently of the influence of other demographic, clinical, and social variables.

## Methods

### Patients

Information on all hospital discharges in New York State during 1995 with *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) code 410.xx in the principal diagnosis position was obtained from the Statewide Planning and Research Cooperative System (SPARCS) database. SPARCS is an agency of the New York State Department of Health that incorporates data on patients hospitalized in acute care facilities from, among other sources, the uniform bill and uniform discharge abstract submitted by hospitals. This method of case selection, based on *ICD-9-CM* codes assigned at the discharging hospital, identified a cohort of patients whose principal diagnosis was acute myocardial infarction, irrespective of procedures coded or diagnosis-related group[29] assigned.

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Only patients whose race was reported as African American or White were included in the complete analyses of this study. As a result of small numbers or vague classifications, patients whose race was reported as Native American, Asian or Pacific Islander, "other," or "unknown" were included in exploratory analyses only. Among patients with more than 1 discharge meeting the selection criteria, only the first hospitalization was included in this study. Hospital readmission was determined by searching the same data set for subsequent admissions during 1995 for each patient after excluding those transferred to another acute care hospital at the time of their index discharge.

Insurance status was determined by "principal expected reimbursement at admission" codes present in the field of each discharge record. Insurance status was designated "Medicaid" if the code for Medicaid fee for service was present in this field. Insurance status was designated "non-Medicaid" if a code for an indemnity or commercial payer or health maintenance organization (HMO) was found in this field. Medicare patients are much older and at higher risk for poor outcomes (including death) than others with acute myocardial infarction, and they often receive care different from that of other, younger patients.[10,18] Thus, they were excluded. Patients with the following insurance codes were also excluded: veterans' or Civilian Health and Medical Program of the Uniformed Services (CHAMPUS) benefits, "other government insurance," workers' compensation, Medicaid–HMO, self-pay, "other," and "no charge."

Comorbid illness was determined by searching up to 14 secondary *ICD-9-CM* diagnosis codes for each patient. The Charlson comorbidity index and its age-adjusted variant[30,31] were used in quantifying total comorbid disease for each patient. Process of care was determined by searching the principal procedure code and up to 14 secondary procedure codes for each patient. A patient was classified as receiving care from a cardiologist if his or her attending physician of record was listed as a specialist in cardiovascular diseases according to physician specialty codes present in the data set.

A quantitative estimate of SES was derived by assigning to each patient the value equivalent to median household income among residents in his or her home postal zip code. Income data were derived from the 1990 United States census and were expressed in 1989 dollars. Patients were classified as "urban" if their discharge occurred at a hospital located in a county that is part of a federal metropolitan statistical area. The remaining patients were classified as "rural."

Patients were classified as receiving care at a "teaching" hospital if their discharge occurred at a hospital listed as a primary or affiliated institution of an accredited internal medicine or family practice residency program according to the American Medical Association's directory of postgraduate medical training programs.[32] All other patients were classified as receiving care at a "nonteaching" hospital. Each hospital's caseload of acute myocardial infarction discharges was determined. Patients were classified as receiving care at a "high-volume" hospital if they were discharged from a hospital in the highest quintile of cases.

### *Statistical Analyses*

Statistical analyses were performed with SAS software (SAS Institute, Inc, Cary, NC). The 4 dependent variables included in this study were diagnostic cardiac catheterization, percutaneous transluminal coronary angioplasty (PTCA), coronary artery bypass graft (CABG) surgery, and any revascularization procedure (PTCA, CABG, or both). Chi-square tables (for dichotomous variables) and Student unpaired *t* tests (for continuous variables) were used in analyzing differences in crude data between insurance groups.

The significance of insurance type as an independent determinant of procedure use was determined via multiple logistic regression analysis (PROC LOGISTIC). In this process, the following patient characteristics were entered with insurance type into the regression models: age; race; sex; household income; history of hypertension, diabetes, chronic lung disease, renal disease, peripheral vascular disease, or cardiac surgery; type and location of acute myocardial infarction (anterior vs not anterior, non-Q-wave vs not non-Q-wave); complications of acute myocardial infarction (heart failure, atrioventricular block, shock, atrial fibrillation, or ventricular arrhythmia); Charlson comorbidity index value; transfer from another medical facility; hospital caseload volume; and type and location of hospital where treatment was received (urban vs rural, teaching vs nonteaching).

In interpreting results, we considered *P* values of .05 statistically significant. Results are displayed as means (±SD).

## *Results*

### *Patients, Insurers, and Hospitals*

Of the 36 692 patients identified, 23 083 were excluded on the basis of their insurance code, with Medicare (n = 20 257), self-pay (n = 1910), "other" (n = 612), worker's compensation (n = 112), veterans' or CHAMPUS benefits (n = 81), Medicaid–HMO (n = 50), "other government insurance" (n = 37), and "no charge" (n = 24) being the reasons for exclusion. Of 2584 Medicaid patients, 750 (29%) were included in exploratory analyses only on the basis of their race category. Of 11 028 non-Medicaid patients, 1283 (12%) were included in exploratory analyses only.

Thus, the complete analyses for this study included 11 579 African American or White patients, 1834 (16%) in the Medicaid group and 9745 (84%) in the non-Medicaid group. Household income data were missing for 185 patients; all data elements were complete for the remaining 11 394 patients.

Two hundred twenty-six hospitals contributed 1 or more patients to the sample of 11 579. The median caseload was 79 patients per hospital. Of all index discharges, 90% occurred in urban hospitals, whereas 56% and 51% occurred in teaching hospitals and high-volume hospitals, respectively.

### *Demographics, Clinical Characteristics, and Outcomes*

The mean age of the 11 579 patients was 57.1 ± 10.7 years (median = 57, interquartile range = 50 to 63); 1237 (10.7%) were African American, and 3400 (29.4%) were female. The mean unadjusted Charlson comorbidity index value was 1.9 ± 1.3, and the mean age-adjusted value was 3.2 ± 1.8. Mean household income was $37 157 ± $14 006 (median = $34 439, interquartile range = $26 964 to $46 413). Length of hospital stay averaged 6.8 ± 6.0 days, and hospital charges averaged $13 915 ± $13 399. The mortality rate for index hospitalizations was 4.6%. The median duration of postdischarge follow-up was 6.3 months. The hospital readmission rate during this period among patients not transferred to another hospital at the time of their index discharge was 7.8%.

Table 1 displays the demographic characteristics, coexistent illnesses, and comorbidity scores of the cohort stratified by insurance designation. As can be seen, the Medicaid and non-Medicaid populations differed significantly. Medicaid patients were older, and more were African Americans and women. Mean household income was lower among Medicaid patients. The prevalence of hypertension, diabetes, chronic lung disease, renal disease, and peripheral vascular disease was higher in this group. Accordingly, the mean Charlson comorbidity index value was higher among the Medicaid patients as well. Heart failure and atrial fibrillation, as coexistent illnesses or complications of acute myocardial infarction, were more common in Medicaid patients; serious ventricular arrhythmia was less common.

The crude clinical outcomes of the study cohort are shown in Table 2. As can be seen, the Medicaid group had a longer mean length of hospital stay, higher mean hospital charges,

**TABLE 1—Clinical and Demographic Characteristics, Stratified by Insurance Designation: New York State, 1995**

| Characteristic | Medicaid (n=1834) | Non-Medicaid (n=9745) | *P* |
|---|---|---|---|
| Age, y, mean ± SD | 59.3 ± 13.2 | 56.6 ± 10.1 | .001 |
| Female, % | 47.2 | 26.0 | <.001 |
| African American, % | 25.8 | 7.8 | <.001 |
| Nursing home residence, % | 2.3 | 0.4 | <.001 |
| Household income, $, mean ± SD[a] | 29372 ± 10858 | 38626 ± 14048 | .001 |
| Associated cardiac diagnoses, % | | | |
| Anterior myocardial infarction | 24.0 | 25.4 | .20 |
| Non-Q-wave myocardial infarction | 37.8 | 30.0 | <.001 |
| Heart failure | 33.3 | 18.8 | <.001 |
| Atrioventricular nodal block | 5.4 | 4.6 | .12 |
| Shock | 2.9 | 2.4 | .18 |
| Atrial fibrillation | 9.0 | 7.2 | .009 |
| Serious ventricular arrhythmia | 8.8 | 11.8 | <.001 |
| Previous cardiac surgery | 2.7 | 4.8 | <.001 |
| Comorbid medical diagnoses | | | |
| Hypertensive heart disease, % | 47.8 | 39.6 | <.001 |
| Diabetes, % | 33.2 | 21.4 | <.001 |
| Chronic lung disease, % | 15.8 | 10.1 | <.001 |
| Renal disease, % | 10.7 | 5.4 | <.001 |
| Peripheral vascular disease, % | 5.8 | 3.6 | <.001 |
| Charlson comorbidity index, mean ± SD | 2.4 ± 1.6 | 1.8 ± 1.2 | .001 |
| Age-modified comorbidity index, mean ± SD | 3.9 ± 2.2 | 3.0 ± 1.7 | .001 |
| Hospital location, % | | | .11 |
| Rural | 8.7 | 9.9 | |
| Urban | 91.3 | 90.1 | |
| Hospital type, % | | | <.001 |
| Teaching | 68.4 | 53.8 | |
| Nonteaching | 31.6 | 46.2 | |
| Treatment in a high-volume hospital, %[b] | 49.4 | 51.8 | .05 |

[a]Income data were available for 1809 Medicaid patients and 9585 non-Medicaid patients.
[b]Defined as being discharged from a hospital in the highest quintile of acute myocardial infarction caseload volume.

**TABLE 2—Hospital-Based Clinical Outcomes, Stratified by Insurance Designation: New York State, 1995**

| Clinical Outcome | Medicaid (n=1834) | Non-Medicaid (n=9745) | *P* |
|---|---|---|---|
| Length of stay, d, mean ± SD | 8.7 ± 8.2 | 6.5 ± 5.4 | .001 |
| Hospital charges, $, mean ± SD | 16160 ± 15612 | 13492 ± 12897 | .001 |
| In-hospital mortality, % | 8.2 | 4.0 | <.001 |
| Hospital readmission, %[a] | 8.7 | 7.6 | .17 |

[a]Patients transferred to another acute care hospital at the time of their index discharge were excluded from the analysis of hospital readmission, leaving 1449 patients in the Medicaid group and 6354 in the non-Medicaid group.

and higher in-hospital mortality. Hospital readmission prevalence rates were equivalent.

### *Process of Care*

Medicaid patients were less likely than non-Medicaid patients to be admitted to the hospital in transfer from another acute care hospital (7.0% vs 9.5%; $P<.001$). The percentage of patients whose attending physicians were cardiologists was equivalent between the groups (Medicaid, 36.6%; non-Medicaid, 36.0%; $P=.58$).

### *Exploratory Analyses of Procedure Use*

A total of 1237 African American patients were identified from 147 hospitals; 10342 White patients were identified from 219 hospitals; 47 Native American patients were identified from 26 hospitals; 200 Asian or Pacific Islander patients were identified from 73 hospitals; 991 patients with the race designation "other" were identified from 117 hospitals; and 792 patients with the race designation "unknown" were identified from 57 hospitals. Crude rates of use of cardiac catheterization, PTCA, CABG, and any revascularization procedure for each race group are shown in Table 3, stratified by insurance designation. A predominant trend was that Medicaid patients were less likely to undergo procedures than non-Medicaid patients, with differences most often achieving statistical significance among the White, "other," and "unknown" race groups.

### *Complete Analyses of Procedure Use*

Crude rates of use of cardiac catheterization, PTCA, CABG, and any revascularization procedure for the 11579 African American or White patients and for the 4 race–sex subgroups stratified by insurance designation are shown in Table 4. As can be seen, Medicaid patients exhibited less frequent use of cardiac catheterization, PTCA, and any revascularization procedure. Crude rates of CABG were comparable between Medicaid and non-Medicaid patients. Qualitatively similar trends extended across all 4 race–sex subgroups, with the most profound insurance-based differences occurring among White women.

The results of the logistic regression analyses are shown in Table 5. After adjustment for patient and hospital characteristics, insurance remained a significant predictor, with Medicaid patients being 32% less likely to undergo cardiac catheterization, 33% less likely to undergo PTCA, and 28% less likely to undergo any revascularization procedure. The adjusted odds ratio (OR) for CABG associated with Medicaid insurance was not statistically different from 1.0 (OR=0.88; 95% confidence interval [CI]=0.69, 1.12; $P=.29$). There were general trends for women, African Americans, and older patients to be less likely to undergo procedures. Patients transferred from other acute care hospitals and patients treated in teaching and high-volume hospitals were more likely to undergo procedures (Table 5).

### *Diagnostic Cardiac Catheterization as a Determinant of Revascularization Rates*

In comparison with those who did not, patients who underwent diagnostic cardiac catheterization were substantially more likely to undergo PTCA (crude OR=11.02; 95% CI=9.68, 12.54; $P<.001$), CABG (crude OR=6.77; 95% CI=5.76, 7.97; $P<.001$), or any revascularization procedure (crude OR=11.43; 95% CI=10.27, 12.72; $P<.001$). Among the 4633

**TABLE 3—Crude Rates of Use of Various Cardiac Procedures Among Race Groups, Stratified by Insurance Designation: New York State, 1995**

| Race Group | N | Cardiac Catheterization, No. (%) | PTCA, No. (%) | CABG, No. (%) | Any Revascularization Procedure, No. (%) |
|---|---|---|---|---|---|
| African American | 1237 | | | | |
| Medicaid | 474 | 156 (32.9) | 32 (6.8) | 19 (4.0) | 51 (10.8) |
| Non-Medicaid | 763 | 281 (36.8) | 66 (8.6) | 31 (4.1) | 97 (12.7) |
| White | 10342 | | | | |
| Medicaid | 1360 | 455 (33.5)* | 99 (7.3)* | 90 (6.6) | 187 (13.8)* |
| Non-Medicaid | 8982 | 3741 (41.6) | 1187 (13.2) | 608 (6.8) | 1764 (19.6) |
| Native American | 47 | | | | |
| Medicaid | 22 | 9 (40.9) | 2 (9.1) | 1 (4.6) | 3 (13.6) |
| Non-Medicaid | 25 | 11 (44.0) | 3 (12.0) | 3 (12.0) | 6 (24.0) |
| Asian or Pacific Islander | 200 | | | | |
| Medicaid | 82 | 40 (48.8) | 12 (14.6) | 4 (4.9) | 16 (19.5) |
| Non-Medicaid | 118 | 51 (43.2) | 20 (17.0) | 7 (5.9) | 27 (22.9) |
| Other | 991 | | | | |
| Medicaid | 483 | 168 (34.8)* | 40 (8.3)* | 28 (5.8)* | 66 (13.7)* |
| Non-Medicaid | 508 | 257 (50.6) | 114 (22.4) | 49 (9.6) | 159 (31.3) |
| Unknown | 792 | | | | |
| Medicaid | 163 | 56 (34.4)* | 24 (14.7)* | 20 (12.3) | 44 (27.0)* |
| Non-Medicaid | 629 | 369 (58.7) | 144 (22.9) | 95 (15.1) | 234 (37.2) |

*Note.* PTCA = percutaneous transluminal coronary angioplasty; CABG = coronary artery bypass graft.
*$P \leq .05$ (for comparison with non-Medicaid subgroup).

**TABLE 4—Crude Rates of Use of Various Cardiac Procedures, Stratified by Insurance Designation and Race–Sex Subgroup: New York State, 1995**

| Patient Group | N | Cardiac Catheterization | PTCA | CABG | Any Revascularization Procedure |
|---|---|---|---|---|---|
| All patients | 11579 | | | | |
| Medicaid, No. (%) | 1834 | 611 (33.3) | 131 (7.1) | 109 (5.9) | 238 (13.0) |
| Non-Medicaid, No. (%) | 9745 | 4022 (41.3) | 1253 (12.9) | 639 (6.6) | 1861 (19.1) |
| Odds ratio (95% CI)[a] | | 0.71 (0.64, 0.79)* | 0.52 (0.43, 0.63)* | 0.90 (0.73, 1.11) | 0.63 (0.55, 0.73)* |
| White men | 7464 | | | | |
| Medicaid, No. (%) | 740 | 239 (39.6) | 63 (8.5) | 66 (8.9) | 127 (17.2) |
| Non-Medicaid, No. (%) | 6724 | 2854 (42.4) | 944 (14.0) | 476 (7.1) | 1394 (20.7) |
| Odds ratio (95% CI)[a] | | 0.89 (0.76, 1.04) | 0.57 (0.44, 0.74)* | 1.28 (0.98, 1.68) | 0.79 (0.65, 0.97)* |
| African American men | 715 | | | | |
| Medicaid, No. (%) | 229 | 73 (31.9) | 18 (7.9) | 8 (3.5) | 26 (11.4) |
| Non-Medicaid, No. (%) | 486 | 175 (36.0) | 42 (8.6) | 17 (3.5) | 59 (12.1) |
| Odds ratio (95% CI)[a] | | 0.83 (0.60, 1.16) | 0.90 (0.51, 1.60) | 0.99 (0.42, 2.35) | 0.93 (0.57, 1.52) |
| White women | 2878 | | | | |
| Medicaid, No. (%) | 620 | 162 (26.1) | 36 (5.8) | 24 (3.9) | 60 (9.7) |
| Non-Medicaid, No. (%) | 2258 | 887 (39.3) | 243 (10.8) | 132 (5.8) | 370 (16.4) |
| Odds ratio (95% CI)[a] | | 0.55 (0.45, 0.66)* | 0.51 (0.36, 0.73)* | 0.65 (0.42, 1.01) | 0.55 (0.41, 0.73)* |
| African American women | 522 | | | | |
| Medicaid, No. (%) | 245 | 83 (33.9) | 14 (5.7) | 11 (4.5) | 25 (10.2) |
| Non-Medicaid, No. (%) | 277 | 106 (38.3 ) | 24 (8.7) | 14 (5.1) | 38 (13.7) |
| Odds ratio (95% CI)[a] | | 0.83 (0.58, 1.18) | 0.64 (0.32, 1.26) | 0.88 (0.39, 1.98) | 0.72 (0.42, 1.22) |

*Note.* PTCA = percutaneous transluminal coronary angioplasty; CABG = coronary artery bypass graft; CI = confidence interval.
[a]Crude odds ratios and 95% confidence intervals for likelihood of Medicaid patients undergoing each procedure, relative to non-Medicaid patients, within each patient group.
*$P \leq .05$.

patients who underwent cardiac catheterization, Medicaid patients were less likely to undergo PTCA (crude OR = 0.64; 95% CI = 0.52, 0.79; $P < .001$) or any revascularization procedure (crude OR = 0.74; 95% CI = 0.62, 0.89; $P = .001$) but were not less likely to undergo CABG (crude OR = 1.07; 95% CI = 0.83, 1.37; $P = .60$).

Even after adjustment for performance of cardiac catheterization (and other demographic and clinical factors and hospital characteristics), Medicaid patients were less likely to undergo PTCA (adjusted OR = 0.74; 95% CI = 0.60, 0.91; $P = .005$) or any revascularization procedure (adjusted OR = 0.81; 95% CI = 0.68, 0.97; $P = .02$). However, in this context, Medicaid was again not predictive of CABG use (adjusted OR = 0.97; 95% CI = 0.76, 1.23; $P = .78$).

**TABLE 5—Adjusted Odds Ratios for Use of Various Cardiac Procedures Associated With Insurance Designation and Other Sociodemographic Variables: New York State, 1995**

| Independent Variable | Odds Ratio (95% CI) | | | |
|---|---|---|---|---|
| | Cardiac Catheterization | PTCA | CABG | Any Revascularization Procedure |
| Medicaid insurance | 0.68 (0.59, 0.77)* | 0.67 (0.55, 0.83)* | 0.88 (0.69, 1.12) | 0.72 (0.60, 0.86)* |
| Female | 0.93 (0.84, 1.03) | 0.82 (0.71, 0.96)* | 0.67 (0.55, 0.81)* | 0.71 (0.62, 0.81)* |
| African American | 0.74 (0.63, 0.86)* | 0.79 (0.62, 1.00)* | 0.62 (0.45, 0.85)* | 0.68 (0.55, 0.84)* |
| Older age[a] | 0.97 (0.97, 0.98)* | 0.98 (0.98, 0.99)* | 1.00 (0.99, 1.01) | 0.99 (0.98, 0.99)* |
| Higher household income[b] | 0.93 (0.89, 0.97)* | 1.07 (1.01, 1.14)* | 0.92 (0.86, 1.00)* | 1.01 (0.96, 1.07) |
| Transfer from another hospital | 2.01 (1.71, 2.36)* | 2.83 (2.42, 3.30)* | 4.15 (3.48, 4.96)* | 5.52 (4.75, 6.42)* |
| Hospital volume[b] | 2.34 (2.20, 2.49)* | 2.79 (2.45, 3.19)* | 2.33 (1.98, 2.76)* | 2.93 (2.62, 3.27)* |
| Teaching hospital | 4.50 (4.06, 4.98)* | 5.57 (4.55, 6.82)* | 4.08 (3.13, 5.32)* | 5.82 (4.93, 6.88)* |
| Rural hospital[c] | 0.42 (0.33, 0.52)* | . . . | . . . | . . . |

*Note.* Associated cardiac and comorbid medical diagnoses were included in logistic regression models but are omitted here.
PTCA = percutaneous transluminal coronary angioplasty; CABG = coronary artery bypass graft; CI = confidence interval.
[a]Unit for age is 1 year.
[b]Household income and hospital volume are expressed in quintiles.
[c]Too few patients who were treated in rural hospitals underwent PTCA or CABG to permit inclusion of this variable in the models.
*$P \leq .05$.

## *Discussion*

In this study, we examined the influence of insurance payer status and other demographic and clinical factors and hospital characteristics on the use of invasive procedures among patients treated for acute myocardial infarction. The principal findings were as follows. First, Medicaid patients with acute myocardial infarction differ from non-Medicaid patients in many important ways, including age, race, and sex mix; SES; coexistent illnesses; prevalence of clinical complications of acute myocardial infarction; and location of care. Second, crude rates of use of cardiac catheterization and PTCA during a hospitalization for acute myocardial infarction are lower among Medicaid patients, whereas CABG use is comparable among Medicaid and non-Medicaid patients.

Third, after adjustment for demographic and clinical factors and hospital characteristics, Medicaid insurance is a significant independent negative predictor of cardiac catheterization, PTCA, and any revascularization procedure. Fourth, after adjustment for insurance, location of care, and other relevant variables, older age, African American race, and female sex are also significant negative predictors of procedure use.

Finally, insurance-related differences in use of diagnostic cardiac catheterization do not fully explain the lower rates of use shown for PTCA and any revascularization procedure; Medicaid continued to predict lower use of these services even after adjustment for catheterization and other factors. In aggregate, these results confirm that age, race, sex, and location of care are important determinants of the process of care for acute myocardial infarction but do not fully explain the lower use of procedures among Medicaid patients.

### *Influence of Insurance, Race, Sex, and SES on Cardiac Procedure Use*

Carlisle et al. reported that, after adjustment for age, sex, and comorbid illness, uninsured ethnic minority patients and minority patients with Medicaid, Medicare, and HMO insurance were less likely to undergo catheterization, PTCA, and CABG than Whites within the same insurance class.[17] However, no effect of race or ethnicity was found among patients with private insurance. This study was fundamentally different from ours in that it was not restricted to patients with acute myocardial infarction, there was no adjustment for measures of SES, and there were no quantitative comparisons across insurance groups.

Gornick et al. reported that income-adjusted rates of PTCA and CABG use were lower among African Americans than among Whites.[19] However, this study was limited to Medicare beneficiaries and included many patients without acute myocardial infarction. Moreover, use rates were not adjusted for sex, comorbid illness, or hospital type.

Daumit et al. reported that race-related differences in use of cardiac procedures narrowed once patients developed end-stage renal disease and were treated in a comprehensive care program that included enrollment in Medicare.[25] This study suggested that insurance coverage may be an important modifier of race-related trends in the use of cardiac procedures. However, the study did not specifically address the influence of Medicaid insurance on procedure use.

In a study of patients who had undergone cardiac catheterization, Leape et al. noted that PTCA and CABG underuse was greater among uninsured patients than among insured patients.[12] However, only 16% of the 631 study patients had Medicaid insurance, and the study was not restricted to patients with acute myocardial infarction.

Sada et al. reported that Medicaid patients with acute myocardial infarction undergo fewer invasive cardiac procedures than do patients with HMO or indemnity insurance.[26] Thus, our study and the study by Sada et al. provide consistent and compelling evidence that Medicaid patients are less likely to be treated aggressively after acute myocardial infarction. The patient sample in Sada et al.'s study was drawn from selected institutions providing on-site cardiac catheterization services, while we examined patients from all types of acute care hospitals. Also, Sada et al.'s sample was drawn from multiple states, while we selected patients from a geographic region (New York State) whose residents have been shown to exhibit lower rates of use of invasive procedures for coronary artery disease and acute myocardial infarction.[33] These 2 factors are the likely explanations for the discrepant use of catheterization in the 2 studies.

Although differing in their selection of hospitals and patients, the present study and that of Sada et al. speak to similar issues surrounding insurance-based biases in the management of acute myocardial infarction. Sada et al.'s study addressed Medicaid-related treatment differences existent in catheterization hospitals across a broad geographic territory of the United States, while our study confirms that these process variations are present across a wide spectrum of hospital types located within a finite geographic region. Because the present study included consecutive patients without regard to hospital type, it may

yield conclusions that are generalizable to a broader array of health care institutions.

### *Explanations for Lower Rates of Procedure Use*

The Medicaid population differs from other insurance groups in terms of demographic and clinical characteristics as well as location of care.[11–13,17,25–28] To our knowledge, no previous study of process of care after acute myocardial infarction has attempted to address these multiple issues in a single comprehensive analysis. In our study, Medicaid insurance was a significant independent negative predictor of procedure use even after adjustment for relevant demographic and clinical factors and hospital characteristics. This pattern emerged in the face of equal access to cardiovascular specialists and more frequent admission to teaching hospitals among the Medicaid patients. Thus, the lower use of procedures in the Medicaid cohort cannot be fully attributed to the explanatory variables that were examined in our analyses, suggesting that other factors must be playing a role.

One possible explanation is that choices and preferences differed between the Medicaid and non-Medicaid patients. Minorities and economically disadvantaged patients are more likely to decline invasive procedures than other groups.[7,12,34,35] Because information regarding procedure refusal was not captured in our data set, we cannot fully address this issue. However, previous authors have argued that patient preferences explain only a small portion of race- or SES-based differences in cardiac care.[7,12,35,36]

A second explanation is that the differences in procedure use between insurance groups might be explained by excessive use of procedures among non-Medicaid patients rather than underuse among the Medicaid cohort. Because our study did not examine quality of care using explicit criteria and chart-by-chart review,[7,12] we cannot fully address this issue. However, considering the low use of catheterization among Medicaid patients in our cohort relative to national norms,[9] we speculate that such a phenomenon, if present, does not fully explain the intergroup differences. Moreover, any variation in care after acute myocardial infarction that is based solely on insurance status and not clinical or biological factors could be considered discriminatory.[36]

A third factor may relate to perceived severity of illness and risk of procedures among the Medicaid patients. Perhaps the burden of coexistent illness in the Medicaid group (hypertension, diabetes, renal disease, and peripheral vascular disease), together with real or perceived financial or cultural barriers to ideal postprocedural medical care, served as a deterrent to physicians who might otherwise perform invasive procedures.

Finally, medical economics and physician (and hospital) incentives may be important. The financial disincentives of caring for Medicaid patients are apparent and are probably worsening as government funding for health care is further reduced. Some[12,26,37,38] but not all[27,39] studies have shown that resource use declines owing to a reduction in discretionary services when constrained reimbursement or other financial disincentives are applied to the health care setting. Although such forces may be at work in the management of Medicaid patients after acute myocardial infarction, they are difficult to quantify without a validated measurement tool. A controlled comparison of Medicaid–HMO and other HMO patients that involves adjustment for relevant covariables might provide the opportunity to perform this type of analysis. Unfortunately, the number of Medicaid–HMO patients in the SPARCS data set (n = 50) was too small to permit such an analysis.

### *Limitations*

Our study was based on retrospective analyses of an administrative discharge database. Disease severity cannot be adequately captured in such sources of information, given the lack of data regarding disease-specific severity, functional status, and well-being.[20,40,41] Furthermore, ideal assessments of appropriateness and quality of care are not possible from these sources of data.[20,40] Because no method of truly accurate adjustment for clinical severity or measurement of quality is possible in the case of administrative databases, the complex relationships between patient mix, insurance payers, quality of care, and outcomes may be incompletely characterized.

Furthermore, our data were limited to hospital-based information, such that our conclusions apply only to in-hospital process of care and clinical outcomes. As such, these data do not address the more global issue of reduced access to care among Medicaid, minority, or poor patients because they fail to capture information on patients with acute myocardial infarction who are not hospitalized. Likewise, no data were available regarding catheterization and revascularization during the period following discharge for patients who did not undergo invasive treatment during their index hospitalization. Finally, although measurement of SES based on zip code–derived median household income has validity, it may be less robust than measurement based on individual income or other factors.[19]

### *Conclusions*

Factors other than age, race, sex, SES, coexistent illness, and location of care account for lower rates of use of invasive procedures among Medicaid patients. The influence of Medicaid insurance on medical practice and process of care, including the role of patient preferences and economic incentives, deserves investigation. □


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## Contributors

E. F. Philbin planned the study, analyzed the data, and wrote the paper. P. A. McCullough and T. G. DiSalvo assisted in the study design, data analyses, and the writing of the paper. G. W. Dec and W. D. Weaver contributed to the writing of the paper. P. L. Jenkins supervised the data analyses.

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