Mental Disorders and Use of Cardiovascular Procedures After Myocardial Infarction

Benjamin G. Druss, MD, MPH
David W. Bradford, PhD
Robert A. Rosenheck, MD
Martha J. Radford, MD
Harlan M. Krumholz, MD

Growing literature has used differential rates of cardiovascular procedures as an indicator of potential inequalities in the US health care system. These practice pattern variations, their causes, and their potential implications have been most extensively studied for blacks and women. A number of factors, many parallel- ing those described for race and sex, might also lead to lower procedure rates among individuals with mental disorders. First, mental disorders are commonly associated with medical comorbidity. Second, chronic mental disorders can be associated with unemployment and low socioeconomic status, which could reduce availability of medical technology through uninsur ance or reduced geographic access to tertiary medical centers. Third, the cognitive, affective, and social manifestations of mental disorders might complicate both the process of informed consent and the provision of effective aftercare. Finally, medical providers’ discomfort in treating patients with mental disorders might make them reluctant to offer these patients aggressive treatment even when medically appropriate.

There has been little empirical examination of the barriers to medical care faced by individuals with serious mental disorders. Indeed, studies have found that psychiatric symptoms are commonly associated with increased use of medical services. However, this literature has focused on patients with subsyndromal and previously undetected psychiatric symptoms, who would not be expected to encounter the barriers to medical care seen in pa-

Context A number of studies have found race- and sex-based differences in rates of cardiovascular procedures in the United States. Similarly, mental disorders might be expected to be associated with lower rates of such procedures on the basis of clinical, socioeconomic, patient, and provider factors.

Objective To assess whether having a comorbid mental disorder is associated with a lower likelihood of cardiac catheterization and/or revascularization after acute myocardial infarction.

Design Retrospective cohort study using data from medical charts and administrative files as part of the Cooperative Cardiovascular Project.

Setting Acute care nongovernmental hospitals in the United States.

Patients National cohort of 113,653 eligible patients 65 years or older who were hospitalized for confirmed acute myocardial infarction between February 1994 and July 1995.

Main Outcome Measures Likelihood of cardiac catheterization, percutaneous transluminal coronary angioplasty (PTCA), or coronary artery bypass graft (CABG) surgery during the index hospitalization, comparing patients with and without mental disorders (classified as schizophrenia, major affective disorder, substance abuse/dependence disorder, or other mental disorder).

Results Compared with the remainder of the sample, patients with any comorbid mental disorder (n = 5365; 4.7%) were significantly less likely to undergo PTCA (11.8% vs 16.8%; P < .001) or CABG (8.2% vs 12.6%; P < .001). After adjusting for demographic, clinical, hospital, and regional factors, individuals with mental disorders were 41% (for schizophrenia) to 78% (for substance use) as likely to undergo cardiac catheterization as those without mental disorders (P < .001 for all). Among those undergoing catheterization, rates of PTCA or CABG for patients with mental disorders were not significantly different from rates for patients without mental disorders (for those with any mental disorder, P = .12 for PTCA and P = .06 for CABG). In multivariate models, the 30-day mortality did not differ between patients with and without mental disorders.

Conclusions In this study, individuals with comorbid mental disorders were substantially less likely to undergo coronary revascularization procedures than those without mental disorders. Further research is needed to understand the degree to which patient and provider factors contribute to this difference and its implications for quality and long-term outcomes of care.

Author Affiliations: Departments of Psychiatry (Drs Druss and Rosenheck) and Epidemiology and Public Health (Drs Druss, Rosenheck, and Krumholz), Yale University School of Medicine, VA Northeast Program Evaluation Center and the VA-Connecticut Mental Illness Research, Education and Clinical Center (Drs Druss and Rosenheck), Yale-New Haven Hospital Center for Outcomes Research and Evaluation (Drs Radford and Krumholz), Section of Cardiovascular Medicine, Department of Medicine, Yale University (Drs Radford and Krumholz), New Haven, Conn; Qualidigm, Middletown, Conn (Drs Radford and Krumholz); and Center for Health Care Research, Medical University of South Carolina, Charleston (Dr Bradford).

Corresponding Author and Reprints: Benjamin G. Druss, MD, MPH, 950 Campbell Ave/116A, West Haven, CT 06516 (e-mail: benjamin.druss@yale.edu).
tients with serious mental illness.15 Furthermore, psychosomatic symptoms would be expected to lead to higher costs when patient-perceived need is the main instigator of medical service use. Mental symptoms are less clearly associated with costs of procedures such as diagnostic tests, which are largely based on physician discretion.16

In this study, we examine the association between presence of a serious mental disorder and use of cardiac catheterization and coronary revascularization for a national sample of Medicare enrollees treated for acute myocardial infarction. We test the hypothesis that, compared with individuals without mental disorders, patients with mental disorders will have lower rates of coronary revascularization procedures after acute myocardial infarction.

**METHODS**

**Sampling Frame**

This study was conducted as part of the Cooperative Cardiovascular Project, a project sponsored by the Health Care Financing Administration as part of a continuous quality improvement initiative for Medicare beneficiaries.17,18 The Cooperative Cardiovascular Project sample was identified from hospital bills in the Medicare National Claims History File for claims submitted under fee-for-service plans between February 1994 and July 1995. The initial cohort included all patients discharged from acute care hospitals with a principal diagnosis of acute myocardial infarction according to the *International Classification of Diseases, Ninth Revision, Clinical Modification*19 (ICD-9-CM; code 410). Data reliability was monitored by monthly random reabstractions, with overall variable agreement averaging more than 90%.20

The study sample was limited to patients 65 years or older with a confirmed acute myocardial infarction, as described previously.17 Transfers (ie, cases during the study period in which the discharge date of the first hospitalization matched the admission date to a second hospital) were linked to form a continuous episode of care. Patients for whom the initial hospitalization represented a transfer from another hospital were not included in the sample. For patients who were transferred to another institution after the initial admission, procedures performed in the transfer institution were considered part of this “index” hospitalization.

Patients whose records indicated that they were terminally ill or who had do-not-resuscitate orders were excluded, since their care would more likely focus on palliation rather than invasive procedures or other aggressive forms of treatment.

**Missing Data**

Approximately one third of patients did not have information on left ventricular function; missing information for this variable was treated as a separate dummy variable in multivariate analyses. For 3 variables, presence of catheterization, coronary artery bypass graft (CABG) surgery, and angioplasty facilities, data were missing for approximately 8% of the sample; however, there were no statistically significant differences in missing data for these variables between patients with and without mental disorders. For all other variables, less than 1% of data were missing.

**Independent Variables**

**Mental Illness.** Admission ICD-9-CM diagnoses identified coexisting mental diagnoses deemed current and ongoing at the time of index admission: (1) schizophrenia (ICD-9-CM codes 295.00-295.99), (2) major affective disorder (ICD-9-CM codes 296.00-296.99), (3) substance abuse and dependence disorders (ICD-9-CM codes 303.00-305.99), and (4) other mental disorders (ICD-9-CM codes 295.00-319.99, which did not fall into the first 3 categories). Organic psychotic conditions (ICD-9-CM codes 290.00-294.99), including dementia and delirium, were not included in analyses, since they imply a medical cause and are associated with uniquely high rates of mortality.21

**Clinical and Demographic Covariates.** Table 1 outlines a series of variables identified in the literature as clinically relevant to, or predictive of, use of cardiovascular procedures after myocardial infarction.22-24 These variables include demographic characteristics, cardiac risk factors, cardiac history, admission characteristics (including use of thrombolytic therapy), and left ventricular function.

**Hospital and Regional Characteristics.** Studies have documented considerable geographic and hospital-based variation in the use of cardiovascular procedures after acute myocardial infarction.25-28 Thus, all multivariate models included the following hospital characteristics: number of beds, academic affiliation, for-profit status, and total number of physicians, nurses, residents, and other staff. Presence of on-site catheterization, percutaneous transluminal coronary angioplasty (PTCA), and open heart surgical facilities are all important predictors of cardiac interventions after myocardial infarction22-24,29; thus, these variables were also included in all multivariate analyses. Transfer status (commonly, from a hospital without to one with such facilities) was also included in all models. Regional characteristics included as covariates in analyses were as follows: state in which the hospitalization occurred, county population, per capita income, per capita physicians, and per capita hospitals.

**Dependent Variables**

The primary outcome of interest was likelihood of PTCA or CABG during the index hospitalization. (As described previously, patients who were transferred after admission were considered part of the index admission.) Because cardiac catheterization is typically the first step in a decision of whether to offer PTCA or CABG, rates of cardiac catheterization and then rates of those procedures after catheterization were also studied. Thirty-day mortality was also examined to better understand how differences in rates of procedures might affect clinical outcomes of care.

**Statistical Methods**

After conducting bivariate analyses on the independent and dependent

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variables of interest, logistic regression models were constructed to model the association between mental disorders and use of cardiovascular procedures, adjusting for potential confounders.

First, each procedure of interest (ie, PTCA or CABG) was modeled as a function of mental disorder, adjusting for the demographic and clinical variables outlined in Table 1 and the hospital and regional characteristics outlined herein. Each multivariate analysis was modeled first for a summary “any mental disorder” variable and then in a separate model comparing schizophrenia, affective disorders, substance abuse, and other disorders to a group with no mental disorder. Second, a 2-stage set of models was run to examine the odds of cardiac catheterization and revascularization in the subgroup of patients undergoing catheterization.

Finally, a set of equations was used to model 30-day mortality as a function of mental disorders. To examine the possible role played by differing procedure rates on clinical outcomes, mortality was modeled as function of mental disorders with all covariates listed herein and mental disorders (all covariates listed herein) and PTCA and CABG. Again, all analyses were run first with a dichotomous “any mental disorder” variable and in a separate equation that compared the disaggregated mental disorder variable to a group with no mental disorder.

The c-statistic, which represents how well a model discriminates between patients with and without a dichotomous outcome, indicated that the overall regression models were good predictors of catheterization (c = 0.79), revascularization (c = 0.75-0.77), and 30-day mortality (c = 0.91-0.92).

Because odds ratios (ORs) may not provide accurate estimates of relative risk when the outcome of interest is relatively common (ie, greater than 10%), risk ratios were derived from adjusted ORs following the method described by Zhang and Yu.

The SAS statistical software package, version 6.12 (SAS Institute Inc, Cary, NC) was used for all analyses.

### RESULTS

#### Characteristics of Patients With and Without Mental Disorders

Of 113,653 patients, 5365 (4.7%) had a secondary diagnosis of a mental disorder. Adjusting for multiple comparisons using the Bonferroni procedure (critical P value .05/25 = .002), patients with mental disorders were more likely to be male and smokers. They were less likely to be discharged home, to have diabetes mellitus, to have a history of a previous myocardial infarction, PTCA, or CABG, or to have received thrombolytic therapy at the time of admission. Using the summary Medicare Mortality Predictor Score, patients with mental disorders had a small but statistically significantly lower risk of mortality at baseline (0.136 vs 0.142, t(113,651) = 3.22, P = .001).

Adjusting for multiple comparisons, patients with mental disorders were significantly more likely to be admitted to hospitals that lacked catheterization, PTCA, or open heart sur-

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Table 1. Characteristics of Sample (N = 113,653)

<table>
<thead>
<tr>
<th>Characteristics*</th>
<th>Any Mental Disorder, No. (%)</th>
<th>No Mental Disorder, No. (%)</th>
<th>Difference, Difference</th>
<th>x² (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographics</td>
<td></td>
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<tr>
<td>Age, y (mean, 75.5 y; SD, 6.9 y)</td>
<td>2674 (49.8)</td>
<td>52,548 (49.0)</td>
<td>8.1 (.02)</td>
<td></td>
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<tr>
<td>65-74</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>75-84</td>
<td>2023 (37.7)</td>
<td>42,763 (39.5)</td>
<td></td>
<td></td>
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<tr>
<td>≥85</td>
<td>668 (12.5)</td>
<td>12,577 (11.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>2570 (47.9)</td>
<td>58,115 (53.7)</td>
<td>68.2 (&lt;.001)</td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td></td>
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<tr>
<td>Black</td>
<td>327 (6.1)</td>
<td>6,838 (6.3)</td>
<td>0.4 (.52)</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>103 (1.9)</td>
<td>2,577 (2.4)</td>
<td>4.7 (.03)</td>
<td></td>
</tr>
<tr>
<td>Discharged home</td>
<td>3,357 (62.6)</td>
<td>69,983 (64.6)</td>
<td>9.4 (.002)</td>
<td></td>
</tr>
<tr>
<td>Cardiac risk factors and history</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Hypertension</td>
<td>2,261 (42.1)</td>
<td>44,099 (40.7)</td>
<td>4.3 (.04)</td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>1,182 (22.0)</td>
<td>28,411 (26.2)</td>
<td>46.9 (&lt;.001)</td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td>1,211 (22.6)</td>
<td>26,591 (24.1)</td>
<td>21.8 (&lt;.001)</td>
<td></td>
</tr>
<tr>
<td>Angina</td>
<td>130 (2.4)</td>
<td>2,572 (2.4)</td>
<td>0.05 (.82)</td>
<td></td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>241 (4.5)</td>
<td>6,345 (5.9)</td>
<td>17.5 (&lt;.001)</td>
<td></td>
</tr>
<tr>
<td>PTCA in past year</td>
<td>523 (9.8)</td>
<td>14,526 (13.4)</td>
<td>59.8 (&lt;.001)</td>
<td></td>
</tr>
<tr>
<td>CABG in past year</td>
<td>301 (5.6)</td>
<td>8,119 (7.5)</td>
<td>26.5 (&lt;.001)</td>
<td></td>
</tr>
<tr>
<td>Admission characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Pulse &gt;100/min</td>
<td>1,363 (25.4)</td>
<td>26,087 (24.1)</td>
<td>4.8 (.03)</td>
<td></td>
</tr>
<tr>
<td>Systolic blood pressure &lt;125 mm Hg</td>
<td>4,020 (74.9)</td>
<td>81,227 (75.0)</td>
<td>0.02 (.90)</td>
<td></td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>1,355 (34.6)</td>
<td>40,549 (37.5)</td>
<td>18.0 (&lt;.001)</td>
<td></td>
</tr>
<tr>
<td>Urea nitrogen level &gt;14.3 mmol/L (40 mg/dL) or creatinine level &gt;177 µmol/L (20 mg/dL)</td>
<td>4,69 (8.7)</td>
<td>10,856 (10.0)</td>
<td>9.4 (.002)</td>
<td></td>
</tr>
<tr>
<td>Shock</td>
<td>82 (1.5)</td>
<td>3,532 (3.3)</td>
<td>49.9 (&lt;.001)</td>
<td></td>
</tr>
<tr>
<td>Total ST elevation &gt;6 mm</td>
<td>899 (16.8)</td>
<td>18,789 (17.4)</td>
<td>1.3 (.26)</td>
<td></td>
</tr>
<tr>
<td>Thrombolytic therapy</td>
<td>1,067 (19.7)</td>
<td>25,556 (23.6)</td>
<td>43.3 (&lt;.001)</td>
<td></td>
</tr>
<tr>
<td>Left ventricular function</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal (&gt;55%)</td>
<td>761 (14.2)</td>
<td>15,256 (14.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild (40%-54%)</td>
<td>1,546 (28.8)</td>
<td>30,816 (28.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate to severe (&lt;40%)</td>
<td>2,764 (51.5)</td>
<td>55,919 (51.6)</td>
<td>1.6 (.24)</td>
<td></td>
</tr>
<tr>
<td>Unmeasured</td>
<td>1,883 (4.7)</td>
<td>36,220 (33.5)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*PTCA indicates percutaneous transluminal coronary angioplasty; CABG, coronary artery bypass graft surgery.
Mental Disorders, Catheterization, and Revascularization

Each mental disorder was associated with a substantial decrease in likelihood of catheterization (Table 3). Schizophrenia was associated with the greatest reduction in rates of the procedure; patients with this disorder were less than half as likely to undergo catheterization as the rest of the population. Among the group undergoing catheterization, 2 mental disorder categories—substance use and other mental disorders—had statistically significant negative associations with use of procedures (substance use with PTCA and other disorders with CABG). The other diagnoses were not significantly associated with use of procedures, although statistical power for these analyses was limited because of the small sample sizes.

**Mental Disorders, Revascularization, and 30-Day Mortality**

In models adjusted for demographic characteristics, cardiac history, admission characteristics, left ventricular function, and hospital characteristics, there were no significant differences in 30-day mortality between patients with and without mental disorders (Table 4). In models that additionally adjusted for PTCA and CABG, there remained no significant differences between patients with and without mental disorders.

**COMMENT**

After myocardial infarction, individuals with serious mental disorders were significantly less likely to undergo cardiac revascularization procedures than those without mental disorders. The difference emerged early during treatment and appeared to be largely explained by differences in rates of referral for cardiac catheterization. These differences were not accompanied by differences in short-term mortality.

Contrary to our original expectations, patients with mental disorders were not medically sicker than other patients; in fact, they appeared to be slightly less ill at baseline. However, the relation between mental disorders and lower procedure rates remained robust after adjusting for cardiac risk factors, admission characteristics, and left ventricular function. Therefore, differences in medical morbidity do not appear to explain the low rates of cardiovascular procedures for patients with mental disorders.

Differences in rates of procedures between the 2 groups remained robust in

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**Table 3. Mental Disorders, Catheterization, and Revascularization***

<table>
<thead>
<tr>
<th>Mental Disorder</th>
<th>PTCA Unadjusted</th>
<th>RR</th>
<th>P</th>
<th>CABG Unadjusted</th>
<th>RR</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental disorder (n = 5365)</td>
<td>11.8</td>
<td>0.75 &lt;.001</td>
<td>8.2</td>
<td>0.68 &lt;.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schizophrenia (n = 188)</td>
<td>9.0</td>
<td>0.55 .01</td>
<td>3.7</td>
<td>0.27 &lt;.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affective (n = 313)</td>
<td>9.3</td>
<td>0.51 .002</td>
<td>7.9</td>
<td>0.63 .02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Substance use (n = 1138)</td>
<td>12.1</td>
<td>0.58 &lt;.001</td>
<td>11.3</td>
<td>0.80 .01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (n = 3724)</td>
<td>11.0</td>
<td>0.77 &lt;.001</td>
<td>7.4</td>
<td>0.68 &lt;.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No mental disorder (n = 108 288)</td>
<td>16.8</td>
<td>. . .</td>
<td>12.6</td>
<td>. . .</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Each column (ie, percutaneous transluminal coronary angioplasty [PTCA] or coronary artery bypass graft [CABG] surgery) is derived from 2 separate logistic regression equations. The first equation models odds of the procedure of interest as a function of all 4 mental disorders, using “no mental disorder” as a comparison group. A second equation models odds of the procedure as a function of a single variable denoting any mental disorder. Each model adjusts for the demographic and clinical variables outlined in Table 1 and hospital and regional covariates outlined in the text. Relative risk (RR) was calculated from odds ratios (ORs) using the following equation: OR/(1 − P0) + (P0 × OR) where P0 is the rate of procedures among patients without mental disorders. Ellipses indicate referent group.

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multivariate analyses that adjusted for availability of technology and other hospital and regional factors. All patients were also covered by Medicare Part A. Thus, it is unlikely that differences in insurance status or availability of technology were the primary explanation for the differing rates of cardiac procedures. However, hospitals in which individuals with mental disorders were treated were less likely to have catheterization, PTCA, and CAGB facilities. Furthermore, previous studies have demonstrated that patients with mental disorders may have particular difficulties in obtaining and maintaining health insurance. These regional and socioeconomic factors might be expected to further widen the gap in rates of procedures found in this population.

Patient preferences have been implicated as contributing to race-based and sex-based differences in use of cardiovascular procedures. For patients with mental disorders, however, preferences may be difficult to distinguish from cases in which cognitive or affective symptoms are leading to a diminished capacity for medical decision making. These differences may be subtle, and thus careful evaluation is warranted when patients refuse treatments that appear to be medically indicated.

The cognitive, behavioral, and social manifestations of mental disorders might also complicate aftercare for individuals with mental disorders. For instance, major depression has been shown to predict lower cardiac medication compliance and higher dropout rates from cardiac rehabilitation programs. However, these factors would be expected to create difficulties not only for patients who undergo invasive procedures, but also for those who are medically managed. The only way to resolve the potential ethical issues involved in deferring invasive treatments based on these concerns is through the use of explicit standards informed by outcome data rather than implicit assumptions.

A final possibility is that physician bias is leading to lower rates of treatment for individuals with mental disorders. Mental disorders continue to carry stigma in both the general community and medical settings. However, although studies of the physician decision making process have suggested that bias might play a role in cardiovascular procedure rates, other authors have warned about prematurely ascribing those differences to physician bias. This study’s results do not make it possible to definitively establish or reject physician bias as a factor contributing to the unexplained differences in procedure rates.

Differences in procedure rates for patients with mental disorders were not accompanied by an increase in 30-day mortality. Other studies have also found that differences in rates of cardiovascular procedures are not necessarily accompanied by differences in mortality rates. At least 2 explanations have been proposed to explain this type of finding. First, short-term mortality is a relatively blunt indicator of health outcomes, and the differences might still represent a sentinel for other, unmeasured differences in quality or long-term outcomes of care. Second, appropriate rates for these procedures are still not known for the general population and are certainly not defined for specific subgroups who present with unique needs or risks. Randomized trials are needed not only to develop standards of care for the general population, but also to focus on these potentially vulnerable subgroups.

Several limitations should be discussed. Most serious mental disorders in the community go unrecognized and untreated by physicians, and hospital claims data may not identify individuals whose mental health diagnoses have been documented in other settings. Thus, these data provide a better indication of how physicians treat patients based on their perception of mental illness than for estimating the true prevalence of mental disorders in the sample. Second, the sample included only adults 65 years or older. Although the study excluded dementia and other “organic” disorders that are less commonly seen in younger adults, further work is needed to assess the generalizability of the results to younger populations. Finally, we have relatively little information on the clinical decision-making process leading to different procedure rates. Therefore, it is difficult to estimate the relative role played by patients and physicians in determining the differing rates of catheterization and revascularization.

The study leaves a number of important questions unanswered. What are the appropriate rates of use of these procedures in the general population and for patients with mental disorders? What are the implications of these differ-
Mental Disorders and Cardiovascular Procedures

Divergent procedures rate for quality and outcomes, such as long-range mortality, impact on mental illness, and course of cardiac illness? How do these findings generalize to other populations, medical procedures, and systems of care? The findings speak to the potential importance of a research agenda for patients with mental disorders paralleling the literature on race- and sex-based practice variations in medical procedures.

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