Outcome Following Acute Myocardial Infarction

Are Differences Among Physician Specialties the Result of Quality of Care or Case Mix?

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Background: Studies to determine whether care by cardiologists improves the survival of patients with acute myocardial infarction (MI) have produced conflicting results, and it is not known what accounts for differences in patient outcome by physician specialty.

Objectives: To evaluate whether cardiologists provide more recommended therapies to elderly patients with acute MI and, if so, to determine whether variations in processes of care account for differences in patient outcome.

Design: Retrospective cohort study using medical chart data and administrative data files.

Setting: All nonfederal acute care hospitals in California.

Patients: A cohort of 7663 Medicare beneficiaries 65 years and older directly admitted to the hospital with a confirmed acute MI from April 1994 to July 1995 with complete data regarding potential contraindications to recommended therapies.

Main Outcome Measures: Percentage of “good” and “ideal” candidates for a given acute MI therapy who actually received that therapy, percentage who received exercise stress testing or coronary angiography, percentage who underwent revascularization, and 1-year mortality, stratified by specialty of the attending physician.

Results: During hospitalization, good candidates for aspirin were more likely to receive aspirin if they were treated by cardiologists (87%; P < .001), general internists (84%; P = .003), general internists (84%; P < .001), or family practitioners (81%; P < .001). Cardiologists were also more likely to treat good candidates with thrombolytic therapy (51%) than were medical subspecialists (29%; P < .001), general internists (40%; P < .001), or family practitioners (27%; P < .001). Patients of cardiologists were 2- to 4-fold more likely to undergo a revascularization procedure. Despite these differences in utilization, we found similar 30-day mortality rates across physician specialties. However, 1-year mortality rates were greater for patients treated by medical subspecialists (odds ratio [OR], 1.9; 95% confidence interval [CI], 1.6-2.3), general internists (OR, 1.4; 95% CI, 1.3-1.6), and family practitioners (OR, 1.7; 95% CI, 1.4-1.9) than for those treated by cardiologists. Adjusting for differences in patient and hospital characteristics markedly reduced the ORs for those treated by medical subspecialists (OR, 1.2; 95% CI, 0.9-1.4), general internists (OR, 1.1; 95% CI, 1.0-1.3), and family practitioners (OR, 1.3; 95% CI, 1.1-1.6), whereas further adjustment for medication use and revascularization procedures had little effect.

Conclusions: Differences in the use of recommended therapies by physician specialty are generally small and do not explain differences in patient outcome. In comparison, differences among patients treated by physicians of various specialties (case mix) have a large impact on patient outcome and may account for the residual survival advantage of patients treated by cardiologists. With the exception of the in-hospital use of aspirin, recommended MI therapies are markedly underused, regardless of the specialty of the physician.

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SUBJECTS AND METHODS

DATA SOURCES

The Cooperative Cardiovascular Project collected data abstracted from the medical charts of Medicare patients in California who were discharged with an acute MI (International Classification of Diseases, Ninth Revision, Clinical Modification, diagnosis code of 410)\(^{26}\) from an acute care hospital. Readmissions (International Classification of Diseases, Ninth Revision, Clinical Modification, code with a fifth digit of 2) were excluded. Hospital claims were selected for an 8-month period from Medicare Part A claims submitted to the Health Care Financing Administration with discharge dates between April 1994 and July 1995. Part A claims data contain demographic data and limited clinical information on all inpatients whose hospital care was billed to Medicare, including the patient’s health insurance claims number and the unique physician identification number (UPIN) of the attending physician. This number was linked to the UPIN data set for 1995 to obtain self-reported primary and secondary physician specialty. Data collected for each patient included dates of hospitalization, demographic characteristics, comorbidities, severity of illness, electrocardiography results, test results from cardiac enzymes, utilization and results of invasive and noninvasive cardiac tests, contraindications to therapy, and treatment. Data reliability was evaluated using the \( \kappa \) statistic, based on an abstraction and reabstraction of 1078 medical records of patient eligibility for medications (aspirin, thrombolysis, \( \beta \)-adrenergic blocking agents, ACE inhibitors) (range, 0.57-0.78) and receipt of these medications (range, 0.88-0.95).

STUDY SUBJECTS

A total of 12,150 Medicare beneficiaries 65 years and older with an acute MI were directly admitted to a hospital in California between April 1994 and July 1995. The diagnosis of acute MI was confirmed by chart review and required either a creatine kinase-MB index above 0.05 or an elevated lactate dehydrogenase level, with lactate dehydrogenase 1 greater than lactate dehydrogenase 2, or 2 of the following 3 criteria: chest pain, creatine kinase-MB level at least 2-fold greater than normal, or evidence of acute MI by electrocardiography. We excluded patients who were transferred to another institution (\( n = 2100 \)) and those with missing data (\( n = 1164 \)). From this group (\( n = 8886 \)), appropriate patients were categorized as “good” or “ideal” candidates for therapy based on previously described criteria (Table 1).\(^{22}\)

PREDICTOR VARIABLE

Physicians were hierarchically labeled as cardiologists (\( n = 3808 \)), medical subspecialists (\( n = 731 \)), internists (\( n = 2298 \)), or family practitioners (\( n = 826 \)) based on primary or secondary self-reported specialty. For example, a physician who reported a primary specialty of internal medicine and a secondary specialty of cardiology would be categorized as a “cardiologist.” Medical subspecialists included physicians who specialized in pulmonary disease, gastroenterology, nephrology, hematology-oncology, endocrinology, infectious disease, rheumatology, critical care, geriatric medicine, or allergy-immunology. There were 558 patients (6.3%) whose physician UPIN did not match the UPIN data file, and 665 patients (7.5%) with an associated UPIN designating a different physician specialty; these patients were excluded from analysis. Thus, the final sample consisted of 7663 patients.

OUTCOME VARIABLES

We evaluated the use of thrombolytic therapy; aspirin during hospitalization; aspirin, \( \beta \)-adrenergic blocking agents, ACE inhibitors, and calcium channel blockers at hospital discharge; and exercise stress tests, echocardiography, coronary angiography, and revascularization procedures (percutaneous transluminal coronary angioplasty and coronary artery bypass graft surgery) during hospitalization. We determined the percentage of good or ideal candidates for a given medical therapy who actually received that therapy. The Cooperative Cardiovascular Project measured 30-day mortality from the day of admission; we used Medicare beneficiary data for 1995 and 1996 to determine mortality during 1 year of follow-up.

STATISTICAL METHODS

We used \( \chi^2 \) tests to evaluate the differences between cardiologists and each other specialty in the treatment of good and ideal candidates for a given medical therapy and in the use of exercise stress tests, echocardiography, coronary angiography, and coronary revascularization procedures. We evaluated the differences in 30-day and 1-year mortality between patients treated by cardiologists and each other specialty using univariate and multivariate logistic regression. We first adjusted for patient demographic, comorbidity, and severity-of-illness characteristics on admission (Table 2).\(^{24,25,27}\) We then adjusted for hospital characteristics, including the volume of admissions for acute MI and the availability of revascularization procedures.\(^{22}\) The number of patients in our cohort admitted to each hospital was used to categorize hospitals as low volume (0-24 patients), intermediate volume (25-49 patients), or high volume (\( \geq 50 \) patients). To measure the availability of revascularization procedures for each hospital, we determined whether angioplasty or bypass surgery was performed in at least one patient in our cohort. We then analyzed additional models that included medication use (aspirin and thrombolysis during hospitalization; \( \beta \)-adrenergic blocking agents, ACE inhibitors, and calcium channel blockers at discharge). We repeated the logistic analyses among patients admitted to hospitals in which revascularization was available and, in subsequent models, adjusted for revascularization procedures. We repeated all analyses among patients who survived hospitalization. Statistical analysis was performed using an SAS statistical package.\(^{28}\) All \( P \) values were 2-sided.

differences in the processes of care due to physician specialty affect patient outcome. To determine whether processes of care or case mix account for differences in patient survival by physician specialty, we examined 30-day and 1-year mortality and how well cardiologists, medical subspecialists, internists, and family practitioners adhered to established practice guidelines for a recent cohort of 7663 Medicare beneficiaries admitted with acute MI.
likely than medical subspecialists, general internists, or hospitalization” was changed to “no death on the first hospital day.”

Regardless of the specialty of the attending physician, the proportion of patients treated appropriately was low, rather, medical subspecialists were more likely to admit patients to hospitals with severe MIs. Compared with other physicians, cardiologists were more likely to have Q-wave MIs. Tachycardia did not differ among groups, patients of cardiologists. Rather, medical subspecialists appeared to treat patients with the most severe MIs—and less than one half of ideal candidates—received an ACE inhibitor. More than 40% of ideal candidates failed to receive an ACE inhibitor. General internists and family practitioners were more likely to avoid calcium channel blockers than were cardiologists. Differences among the specialties were more marked among patients who were good candidates for a given therapy than among ideal candidates.

### Risks Stratification and Revascularization

Patients treated by cardiologists were more likely to undergo risk stratification (exercise stress testing or coronary angiography) than those treated by medical subspecialists, general internists, or family practitioners. Patients of cardiologists were more than twice as likely to undergo coronary angiography than those of other physician specialties. Patients of medical subspecialists and family practitioners were equally likely to undergo exercise stress testing than those of cardiologists, while those treated by general internists were 1.5-fold

<table>
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<tr>
<th>Therapy</th>
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<tr>
<td>Aspirin†</td>
<td>Patients did not die during hospitalization and had no aspirin allergy or intolerance, active bleeding, history of internal bleeding, thrombocytopenia, coagulopathy, or concomitant warfarin sodium therapy.</td>
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<tr>
<td>Good candidates</td>
<td>Patients did not die during hospitalization and had no aspirin allergy or intolerance, active bleeding, history of internal bleeding, thrombocytopenia, coagulopathy, or concomitant warfarin sodium therapy.</td>
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<tr>
<td>Ideal candidates</td>
<td>Patients did not die during hospitalization and had no aspirin allergy or intolerance, active bleeding, history of internal bleeding, thrombocytopenia, coagulopathy, or concomitant warfarin sodium therapy.</td>
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<td>Thrombolysis‡</td>
<td>Patients with ST elevation on electrocardiogram at admission and chest pain starting &lt;6 h before admission; no active bleeding; no history of stroke, internal bleeding, or coagulopathy; no recent surgery, trauma, or cardiopulmonary resuscitation; and no patient refusal.</td>
</tr>
<tr>
<td>Good candidates</td>
<td>Patients with ST elevation on electrocardiogram at admission and chest pain starting &lt;6 h before admission; none of the above, 80 years or younger; and no history of peptic ulcer disease, chronic liver disease, metastatic cancer, or terminal illness.</td>
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<td>β-Adrenergic blocking agents‡</td>
<td>Patients did not die during hospitalization and had no hypotension or shock during hospitalization, SBP &lt;100 mm Hg at discharge, conduction disease or bradycardia, or history of asthma.</td>
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<td>ACE inhibitors‡</td>
<td>Patients did not die during hospitalization and had an LVEF &lt;0.40 with no history of stroke, internal bleeding, or coagulopathy; no recent surgery, trauma, or cardiopulmonary resuscitation; and no patient refusal.</td>
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<td>Good candidates</td>
<td>Patients with none of the above and no left ventricular ejection fraction (LVEF) &lt;0.35, LVEF &gt;0.50 with pulmonary edema or congestive heart failure (CHF), chronic obstructive pulmonary disease, dementia, depression, concomitant insulin therapy, metastatic cancer, or terminal illness.</td>
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<td>Avoiding calcium channel blockers‡</td>
<td>Patients did not die during hospitalization and had no atrial fibrillation or recurrent chest pain &gt;24 h after admission.</td>
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Table 1. Criteria Used to Determine Good and Ideal Candidates for Receiving Therapies for Acute Myocardial Infarction*

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**RESULTS**

### Patient Characteristics

Patients treated by cardiologists were younger, more likely to be male and white, less likely to be nonwhite, and generally with fewer comorbid illnesses than those treated by other physicians (Table 2). Prior cardiac disease was common among all patients. Although the location of the MI did not differ among groups, patients of cardiologists were more likely to have Q-wave MIs. Tachycardia, congestive heart failure, shock, and need for cardiopulmonary resuscitation were not more common in patients treated by cardiologists. Rather, medical subspecialists appeared to treat patients with the most severe MIs. Compared with other physicians, cardiologists were more likely to admit patients to hospitals with a higher volume of patients with MI and with the availability of revascularization procedures.

### Use of Therapies for Acute MI

The proportion of patients treated appropriately was low, regardless of the specialty of the attending physician (Table 3). Overall, cardiologists were somewhat more likely than medical subspecialists, general internists, or family practitioners to treat patients with aspirin and thrombolytic agents, but there were no differences in the prescription of β-adrenergic blocking agents or ACE inhibitors. Only approximately one third of good candidates—and less than one half of ideal candidates—received a β-adrenergic blocking agent. More than 40% of ideal candidates failed to receive an ACE inhibitor. General internists and family practitioners were more likely to avoid calcium channel blockers than were cardiologists. Differences among the specialties were more marked among patients who were good candidates for a given therapy than among ideal candidates.
more likely to undergo stress testing. An echocardiogram was obtained in approximately one half of patients and was most frequently ordered by medical subspecialists. Patients treated by cardiologists were approximately 2- to 4-fold more likely to undergo revascularization procedures than those of medical subspecialists, general internists, or family practitioners.

**MORTALITY**

Unadjusted 30-day mortality rates were 18.9% for patients treated by cardiologists, 25.6% for those treated by medical subspecialists, 21.0% for those treated by general internists, and 21.7% for those treated by family practitioners. After adjusting for differences in patient and hospital characteristics, 30-day mortality was similar for patients treated by medical subspecialists (odds ratio [OR], 0.8; 95% confidence interval [CI], 0.6-1.0), general internists (OR, 0.8; 95% CI, 0.7-1.0), and family practitioners (OR, 0.9; 95% CI, 0.7-1.1) compared with those treated by cardiologists.

At 1 year follow-up, unadjusted mortality was 46.5% for patients of medical subspecialists (OR, 1.9; 95% CI, 1.6-2.3), 39.4% for those of general internists (OR, 1.4; 95% CI, 1.3-1.6), and 43.0% for those of family practitioners (OR, 1.7; 95% CI, 1.4-1.9) compared with 31.3% for those of cardiologists. Adjusting for differences in patient and hospital characteristics markedly reduced the ORs for medical subspecialists (OR, 1.2; 95% CI, 0.9-1.4), general internists (OR, 1.1; 95% CI, 1.0-1.3), and family practitioners (OR, 1.3; 95% CI, 1.1-1.6). By contrast, further adjustment for the use of medications (aspirin, thrombolysis, β-adrenergic blocking agents, ACE inhibitors, and calcium channel blockers) had little effect (Figure 1).

Among patients admitted to hospitals in which revascularization was available, those treated by cardiologists also had decreased mortality (Figure 2).
We found that treatment by a cardiologist was not associated with greater short-term patient survival. However, patients treated by a cardiologist had lower 1-year mortality, even after use of medications and revascularization procedures were included in the models. Residual confounding from unmeasured patient or hospital characteristics, differences in unmeasured processes of care during or after hospitalization, or both are responsible for the observed survival advantage of cardiologists’ patients. In this study, adjusting for differences among patients and hospitals had a large effect on the association between physician specialty and patient mortality, whereas adjusting for differences in the use of recommended medications and revascularization procedures had a relatively small effect. This suggests that residual confounding may account for much of the remaining survival benefit for patients treated by cardiologists. Indeed, Normand et al27 used similar data and found that 27% of the variability in 30-day mortality rates could be explained from admission variables, whereas only 6% could be explained by adding medications and revascularization procedures to their models.

We found that good and ideal candidates for acute MI therapies are undertreated by physicians of all specialties. Underuse of proven therapies for MI has also been avoided by subspecialists (OR, 2.0; 95% CI, 1.6-2.4), general internists (OR, 1.7; 95% CI, 1.5-2.0), and family practitioners (OR, 1.7; 95% CI, 1.4-2.2) compared with cardiologists. Adjusting for patient characteristics and hospital volume markedly reduced those effects for medical subspecialists (OR, 1.1; 95% CI, 0.8-1.4), general internists (OR, 1.3; 95% CI, 1.0-1.5), and family practitioners (OR, 1.4; 95% CI, 1.0-1.9). When use of medications and revascularization procedures were included in the model, however, the ORs for 1-year patient mortality were only marginally reduced for medical subspecialists (OR, 1.0; 95% CI, 0.7-1.3), general internists (OR, 1.2; 95% CI, 1.0-1.5), and family practitioners (OR, 1.2; 95% CI, 0.9-1.6). Since differences in patient survival during hospitalization could affect the opportunity for physicians to provide recommended therapies (such as medications at hospital discharge), we repeated our analyses for patients who survived hospitalization and found similar results (Figure 3 and Figure 4).

**COMMENT**

Only a randomized trial can determine whether care by cardiologists improves the outcome of patients with acute MI. However, ethical and feasibility considerations will likely prevent such a study from being performed. In the absence of a randomized trial, observational data must be used to estimate how specialist care affects patient outcome. Two prior studies regarding the association of physician specialty with 1-year mortality for patients with acute MI reached conflicting results—one showed a benefit for patients treated by cardiologists,24 the other did not.25 To evaluate potential differences in the outcome of patients with acute MI by specialty of the attending physician, and to examine what factors account for these differences, we used a staged analysis that first analyzed unadjusted outcome, then adjusted for patient and hospital characteristics, and finally adjusted for medications and revascularization procedures (process-of-care measures).

We found that treatment by a cardiologist was not associated with greater short-term patient survival. However, patients treated by a cardiologist had lower 1-year mortality, even after use of medications and revascularization procedures were included in the models. Residual confounding from unmeasured patient or hospital characteristics, differences in unmeasured processes of care during or after hospitalization, or both are responsible for the observed survival advantage of cardiologists’ patients. In this study, adjusting for differences among patients and hospitals had a large effect on the association between physician specialty and patient mortality, whereas adjusting for differences in the use of recommended medications and revascularization procedures had a relatively small effect. This suggests that residual confounding may account for much of the remaining survival benefit for patients treated by cardiologists. Indeed, Normand et al27 used similar data and found that 27% of the variability in 30-day mortality rates could be explained from admission variables, whereas only 6% could be explained by adding medications and revascularization procedures to their models.

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documented in other studies. Krumholz et al\textsuperscript{10} found that only 64% of patients without contraindications received aspirin within the first 48 hours. In a study\textsuperscript{21} evaluating the quality of cardiologist care, only 48% of patients with a history of MI and no contraindications to a β-adrenergic blocking agent received that therapy. We also found a substantial overuse of calcium channel blockers, with somewhat greater overuse by cardiologists than other physicians.

The reasons that recommended medications remain underused are not known. Although cardiologists appear to be more knowledgeable than generalists regarding the use of effective therapies for acute MI,\textsuperscript{23} most physicians were aware that therapies such as β-adrenergic blocking agents and thrombolysis are associated with better survival. Nonetheless, we found that the rates of actual medication use, even in ideal candidates, were less than half for β-adrenergic blocking agents and approximately half to a third for thrombolysis. In addition, a more established therapy (β-adrenergic blocking agents) was appropriately used less frequently than a more recently proven therapy (ACE inhibitors). Lack of knowledge is therefore unlikely to explain the suboptimal use of recommended therapies.

Although the potential benefit of revascularization for patients with acute MI has been shown in geographic studies that demonstrate an association be-

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**Figure 1.** Odds ratios (95% confidence intervals) for 1-year mortality—unadjusted and then adjusted for patient characteristics (P), hospital characteristics (H), and medication use—among patients with acute myocardial infarction treated by medical subspecialists, general internists, and family practitioners compared with those treated by cardiologists. Medications included aspirin, thrombolysis, β-adrenergic blocking agents, angiotensin-converting enzyme inhibitors, and calcium channel blockers.

**Figure 2.** Odds ratios (95% confidence intervals) for 1-year mortality—unadjusted and then adjusted for patient characteristics (P), hospital volume (V), and use of medications and revascularization (revasc) procedures—among patients with acute myocardial infarction treated at a hospital with a revascularization capability by medical subspecialists, general internists, and family practitioners compared with cardiologists. Medications included aspirin, thrombolysis, β-adrenergic blocking agents, angiotensin-converting enzyme inhibitors, and calcium channel blockers.

**Figure 3.** Odds ratios (95% confidence intervals) of 1-year mortality for patients who survived hospitalization for acute myocardial infarction—unadjusted and then adjusted for patient characteristics (P), hospital characteristics (H), and medication use—comparing inpatient treatment by medical subspecialists, general internists, and family practitioners with cardiologists. Medications included aspirin, thrombolysis, β-adrenergic blocking agents, angiotensin-converting enzyme inhibitors, and calcium channel blockers.

**Figure 4.** Odds ratios (95% confidence intervals) for 1-year mortality for patients who survived hospitalization for acute myocardial infarction at a hospital with a revascularization capability—unadjusted and then adjusted for patient characteristics (P), hospital volume (V), and the use of medications and revascularization procedures (revasc)—comparing inpatient treatment by medical subspecialists, general internists, and family practitioners with cardiologists. Medications included aspirin, thrombolysis, β-adrenergic blocking agents, angiotensin-converting enzyme inhibitors, and calcium channel blockers.
between higher coronary angiography rates and lower patient morbidity and mortality, not all geographic studies have found this association. We found that patients treated by cardiologists were more likely to undergo revascularization, and use of those procedures accounted for a small portion of the 1-year survival advantage among their patients. Although coronary artery bypass surgery appears to decrease 1-year mortality, subsequent benefits are likely to be even greater. Given our finding that only a third to half of patients undergo exercise stress testing or coronary angiography to identify appropriate candidates for revascularization, strategies to increase the proportion of patients with acute MI receiving some form of risk stratification need to be implemented, especially among physicians who are not cardiologists.

There are a number of important limitations to our study. First, our analyses may have exaggerated the benefits of medications and revascularization procedures, since patients had to have been alive to receive these therapies. However, when we analyzed patients who survived hospitalization, we found similar results. Second, we were unable to determine whether patients who were cared for by generalists received follow-up or consultation with cardiologists. If a substantial proportion of patients attended by generalists or medical subspecialists received cardiology consultation, differences in practice patterns among the physician specialties may have been obscured. Third, excluding transferred patients, may differ from non-transferred patients, may bias mortality and utilization rates by physician specialty; however, assigning a transferred patient to either the referring or the receiving physician would be arbitrary. Finally, physician specialty was determined based on self-report of the attending physician; however, there is a high correlation between self-reported specialty and board certification status.

The results of our study serve as a reminder of the difficulties inherent in quality measurement. Experts in the evaluation of quality of care have debated the relative merits of using process and outcome measures. In interpreting our results, proponents of outcome measures may point out the relatively minor contribution of current process-of-care measurements (medications and revascularization procedures) on patient outcome. On the other hand, given the large effect of patient and hospital characteristics on patient outcome, proponents of process measures might dismiss the differences in patient outcome by physician specialty as residual confounding. It is unlikely that an observational study would resolve this issue. Although we can conclude that differences in the use of recommended therapies by physician specialty do not account for much of a survival benefit for patients treated by cardiologists, we are unable to distinguish whether cardiologists have healthier patients from the possibility that they perform better at unmeasured processes of care.

Continuous quality improvement highlights the importance of monitoring and raising the quality of health care. Although a number of recent studies evaluated efforts to improve the use of effective drug therapies for patients with acute MI, patient outcomes are often used to determine the quality of care. Our study suggests that case mix may complicate the use of patient outcome to determine physician outliers. Using process measures, we found that differences in quality of care by physician specialty are small compared with the overall degree of suboptimal treatment. Therefore, increasing the use of recommended therapies to that provided by cardiologists will only marginally improve quality compared with raising the average level of care. Policies should be aimed at improving the care provided by all physicians.

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REFERENCES

9. ISIS-2 (Second International Study of Infarct Survival) Collaborative Group. Randomised trial of intravenous streptokinase, oral aspirin, both, or neither among