

Special Article

APPROPRIATENESS OF CORONARY ANGIOGRAPHY AFTER MYOCARDIAL INFARCTION AMONG MEDICARE BENEFICIARIES

Managed Care versus Fee for Service

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**ABSTRACT**

**Background** Previous studies have documented that cardiac procedures are performed less frequently in patients enrolled in managed-care plans than in those with fee-for-service coverage. However, it is not known whether this difference is due to less frequent use of cardiac procedures when they are indicated or to less frequent use when they are not indicated.

**Methods** We compared the use of coronary angiography after acute myocardial infarction among Medicare beneficiaries who had traditional fee-for-service coverage with the use among Medicare beneficiaries enrolled in managed-care plans. The analysis was adjusted for differences in demographic and clinical characteristics of the patients and for characteristics of the hospitals to which they were admitted. We studied more than 50,000 beneficiaries in seven states and evaluated their care according to guidelines proposed by the American College of Cardiology and the American Heart Association (ACC-AHA).

**Results** Among the 44 percent of patients in both groups who had ACC-AHA class I indications (those for which angiography is useful and effective), more fee-for-service beneficiaries than managed-care enrollees underwent angiography (46 percent vs. 37 percent,  $P < 0.001$ ). The rate of angiography was very low among patients with class I indications who were admitted to hospitals without angiography facilities (31 percent in the fee-for-service group and 15 percent in the managed-care group,  $P < 0.001$ ). Among patients with class III indications (those for which angiography is not effective), the rate of use was low in both groups (approximately 13 percent).

**Conclusions** In situations in which angiography is thought to be useful, it is used less often among Medicare beneficiaries enrolled in managed-care plans than among those with fee-for-service coverage. Moreover, rates of use among patients with class I indications are fairly low in both groups, suggesting that there is room for improving the care of elderly patients with myocardial infarction, especially those admitted to hospitals without angiography facilities. (N Engl J Med 2000;343:1460-6.)

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THE number of Medicare beneficiaries enrolled in managed-care plans has tripled in the past decade; nearly 7 million Medicare beneficiaries (or 18 percent of all such beneficiaries) were enrolled in managed-care plans as of June 1999.<sup>1,2</sup> As enrollment in managed care has increased, the growth in total medical expenditures has decreased.<sup>3-5</sup> This decrease may be due to a decline in the adoption of new tests or treatments or in the use of existing ones.<sup>4</sup> With the increase in managed-care enrollment and the reduced growth in expenditures, there has been concern about the quality of care provided to managed-care enrollees. This concern is likely to escalate, given that the Medicare+Choice provisions included in the Balanced Budget Act of 1997 will probably lead to an increase in enrollment in managed-care plans<sup>6</sup> and that some plans have recently begun to show signs of financial strain.

Several studies have suggested that patients enrolled in managed-care plans are less likely than patients with fee-for-service coverage to undergo procedures used to diagnose and treat cardiovascular conditions.<sup>7-12</sup> However, it is not known whether this difference is due to less frequent use of cardiac procedures when they are indicated or to less frequent use when they are not indicated. We identified Medicare beneficiaries hospitalized for acute myocardial infarction in seven states and evaluated their care according to guidelines proposed by the American College of Cardiology and the American Heart Association (ACC-AHA).<sup>13</sup> We compared the use of coronary angiography among Medicare beneficiaries who had traditional fee-for-service coverage with its use among Medicare beneficiaries enrolled in managed-care risk plans (i.e., plans that assume full responsibility to pay for all care provided to enrollees).

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## METHODS

### Study Population

We obtained data on Medicare beneficiaries from the Cooperative Cardiovascular Project (CCP) of the Health Care Financing Administration (HCFA).<sup>14-17</sup> We studied patients hospitalized in Florida, Texas, California, Ohio, Pennsylvania, New York, and Massachusetts. The Medicare beneficiaries in these seven states account for over 70 percent of all Medicare beneficiaries enrolled in managed care. For each hospital in each state, we studied patients admitted during a specified eight-month period between February 1994 and July 1995.

#### *Fee-for-Service Sample*

From a sample of 80,005 Medicare beneficiaries with fee-for-service coverage who were included in the CCP, we excluded patients for one or more of the following reasons: 8996 who did not have a confirmed acute myocardial infarction,<sup>15</sup> 6244 without a discharge diagnosis of acute myocardial infarction, 5273 who were under the age of 65 years, 3935 who were over the age of 89 years and therefore not likely to undergo angiography, 3862 with data that were likely to be unreliable for a variety of reasons, 11,568 with missing information that prevented their assignment to an ACC-AHA class, and 2347 who underwent early angiography (<12 hours after the onset of symptoms). These exclusions eliminated a total of 33,684 patients, leaving a sample of 46,321 for analysis.

#### *Managed-Care Sample*

The General Accounting Office identified all managed-care plans in the United States with more than 1000 Medicare beneficiaries (a total of 38 plans) and requested identifying information for patients enrolled in risk plans who had had an acute myocardial infarction. Thirty-seven of the 38 plans, representing 99 percent of enrollees in the seven states, provided this information, which was then cross-linked with data in the CCP. Information on patients whose hospital records were not part of the CCP was sent to the CCP's data-abstraction centers. CCP staff members received hospital records for 92 percent of these patients. We applied the eligibility criteria used for the fee-for-service sample to the managed-care sample and identified 4732 eligible patients from a total sample of 8476 patients in the seven states.

### Sources of Data

The procedures used for data abstraction and quality control in the CCP have been described previously.<sup>14-17</sup> Briefly, HCFA established contracts with two data-abstraction centers. Hospitals sent copies of the patients' records to these centers, where the relevant data were abstracted. We defined the index admission as including any transfer to a second hospital. For patients who were transferred from one hospital to another, data from both hospitals were abstracted.

We obtained information about each hospital from the Medicare Provider of Service file and the American Hospital Association data base.<sup>18</sup> We contacted the hospital by telephone to determine whether it had facilities for performing coronary angiography. If a patient was transferred during the initial admission, we documented the characteristics of the first hospital to which the patient was admitted.

### Indications for Angiography

We studied indications associated with the post-acute phase of infarction (from 12 hours after the onset of symptoms until discharge), which is the period during which 90 percent of all angiographic procedures are performed. Moreover, given the emergency nature of an admission for myocardial infarction, this is the period during which managed-care organizations are most likely to use their own physicians, consultants, and protocols to influence the care of their hospitalized members.

On the basis of data collected from the hospital record, we as-

signed each patient to an ACC-AHA class. A panel of knowledgeable physicians devised the coding algorithm, which is described in the Appendix. Class I includes indications for which angiography is "beneficial, useful, and effective."<sup>13</sup> Class II includes indications for which there are conflicting data on the usefulness of the procedure, with a subclassification according to whether the evidence favors the efficacy of angiography (class IIa) or is less clear-cut (class IIb). Class III includes indications for which angiography is not effective.

### Statistical Analysis

#### *Use of Angiography According to Cohort*

We first compared the two samples according to the percentage of patients assigned to each ACC-AHA class. We then determined the level of underuse of angiography (the percentage of patients assigned to class I who did not undergo angiography) and the level of inappropriate use (the percentage of patients assigned to class III who did undergo angiography) in the overall study population. Although we report utilization rates for class IIa and class IIb, we did not attempt to evaluate underuse or inappropriate use for the patients assigned to these classes, since they include indications for which the efficacy of angiography is uncertain.<sup>13</sup> All reported P values are two-sided.

We compared the unadjusted rates of angiography using Pearson's chi-square test. We calculated adjusted rates according to each ACC-AHA class for the fee-for-service and managed-care groups by standardizing the data to our patient population with the use of a regression-based approach.<sup>19,20</sup> That is, for patients assigned to each ACC-AHA class, we fitted a logistic-regression model that included a variable representing the type of care, and we adjusted the model for demographic variables (age, sex, and race or ethnic group); clinical variables (presence or absence of a history of acute myocardial infarction, congestive heart failure, pulmonary disease, stroke, hypertension, diabetes, or dementia); and characteristics of the hospital (state, teaching status, type of ownership, urban or rural location, and presence or absence of angiography facilities at the admitting hospital). We calculated the adjusted rate of angiography in the fee-for-service group by averaging the predicted probability of angiography, assuming that each patient had fee-for-service coverage and that all the other variables remained unchanged. Similarly, we calculated the adjusted rate of angiography in the managed-care group by averaging the probability of angiography, assuming that each patient was enrolled in a managed-care plan.

To account for the clustering of patients in particular hospitals, we used hierarchical regression models<sup>21,22</sup> to generate the adjusted probabilities, which we estimated with Bayesian Interface Using Gibbs Sampling (BUGS) software.<sup>23</sup> We report 95 percent confidence intervals for the unadjusted and adjusted rates.

There have been several reports that the presence of angiography facilities at the admitting hospital is strongly associated with the use of angiography.<sup>24-27</sup> We therefore determined whether the rate of use of angiography among patients assigned to a particular ACC-AHA class differed between the groups according to the availability of angiography facilities at the hospitals where the patients were admitted.

#### *Use of Angiography in Members of Specific Plans*

We had intended to categorize managed-care enrollees according to the type of plan (independent practice association [IPA] or group- or staff-model plan). Although 56 percent of enrollees belonged to a group- or staff-model plan, two plans accounted for 70 percent of these enrollees. Therefore, instead of stratifying the managed-care group according to the type of plan for the overall comparison with the fee-for-service group, we examined plan-specific practice.

The numbers of enrollees in three plans (one IPA and two group- or staff-model plans) were large enough to allow comparisons according to the ACC-AHA class. We identified the hospital service areas (local markets for inpatient care)<sup>28</sup> in which each plan's

patients were hospitalized and then identified all fee-for-service beneficiaries treated in the same areas. For each ACC–AHA class, we compared the rate of angiography among the enrollees of a plan with the rate among fee-for-service beneficiaries treated in the same hospital service areas. We report the adjusted rates of angiography for each comparison. Given the limited samples available for these plan-specific analyses, we were unable to determine whether a plan's practice differed according to the availability of coronary angiography at the admitting hospital. To maintain confidentiality, we do not identify each plan according to type (IPA or group or staff model).

**RESULTS**

**Characteristics of the Patients**

Table 1 shows the characteristics of the two groups. Patients enrolled in managed-care plans were more

likely to be 65 to 74 years old, male, and nonwhite than those in the fee-for-service group, but they were less likely to have a history of congestive heart failure, pulmonary disease, stroke, or dementia ( $P < 0.001$  for all comparisons). Fee-for-service beneficiaries were more likely than managed-care enrollees to be treated in nonteaching hospitals, rural hospitals, nonprofit hospitals, and hospitals with angiography facilities ( $P < 0.001$  for all comparisons). Overall, 37 percent of fee-for-service beneficiaries and 32 percent of managed-care enrollees underwent angiography between 12 hours after the onset of symptoms and discharge ( $P < 0.001$ ).

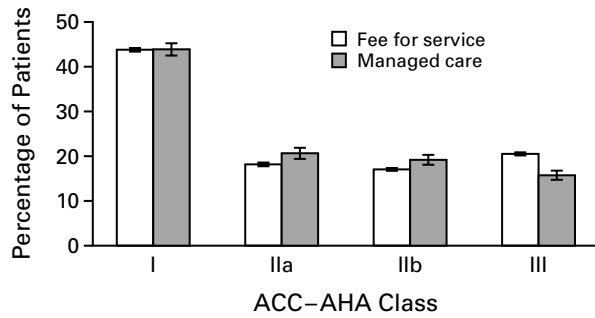
**TABLE 1.** CHARACTERISTICS OF PATIENTS AND ADMITTING HOSPITALS, ACCORDING TO THE TYPE OF MEDICARE COVERAGE.

CHARACTERISTIC	FEE FOR SERVICE (N=46,321)	MANAGED CARE (N=4732)	P VALUE
<b>Patients</b>			
Age — no. of patients (%)			<0.001
65–74 yr	20,271 (44)	2298 (49)	
75–89 yr	26,050 (56)	2434 (51)	
Male sex — no. of patients (%)	24,188 (52)	2718 (57)	<0.001
Race or ethnic group — no. of patients (%)*			<0.001
White	42,115 (91)	3989 (85)	
Black	2,065 (4)	279 (6)	
Other	2,130 (5)	400 (9)	
Medical history — no. of patients (%)			
Myocardial infarction	13,954 (30)	1401 (30)	
Congestive heart failure	10,255 (22)	882 (19)	<0.001
Diabetes mellitus	14,773 (32)	1462 (31)	
Hypertension	28,624 (62)	2978 (63)	
Pulmonary disease	9,805 (21)	887 (19)	<0.001
Stroke	6,503 (14)	533 (11)	<0.001
Dementia	2,674 (6)	155 (3)	<0.001
Coronary-artery bypass surgery	6,175 (13)	649 (14)	
Percutaneous transluminal coronary angioplasty	3,026 (7)	291 (6)	
Angiography performed between 12 hr after the onset of symptoms and discharge — no. of patients (%)	17,341 (37)	1509 (32)	<0.001
<b>Hospitals</b>			
State — no. of patients (%)			<0.001
Florida	7,751 (17)	1254 (27)	
Texas	5,834 (13)	190 (4)	
California	6,617 (14)	2409 (51)	
Ohio	5,480 (12)	61 (1)	
Pennsylvania	9,209 (20)	219 (5)	
New York	7,781 (17)	327 (7)	
Massachusetts	3,649 (8)	272 (6)	
Angiography facilities available — no. of patients (%)	31,683 (68)	3129 (66)	<0.001
Teaching status — no. of patients (%)†			<0.001
Nonteaching	30,618 (66)	3046 (64)	
Minor teaching	11,943 (26)	1259 (27)	
Major teaching	3,757 (8)	427 (9)	
Rural location — no. of patients (%)	5,644 (12)	64 (1)	<0.001
Type of ownership — no. of patients (%)‡			<0.001
Not-for-profit	36,189 (78)	3115 (66)	
For-profit	5,628 (12)	1048 (22)	
Public	4,396 (10)	569 (12)	

\*Data were not available for 11 patients in the fee-for-service group and 64 in the managed-care group.

†Data were not available for three patients in the fee-for-service group.

‡Data were not available for 108 patients in the fee-for-service group.



**Figure 1.** Distribution of Patients According to the American College of Cardiology–American Heart Association (ACC–AHA) Class and Type of Medicare Coverage.

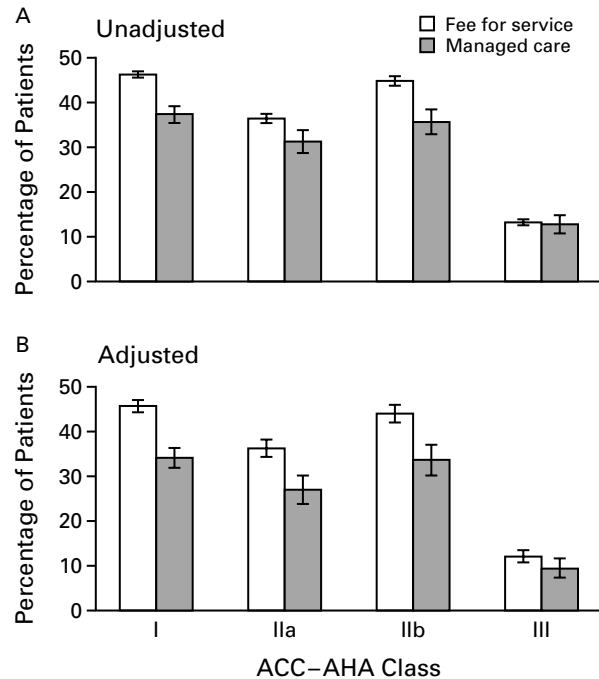
The I bars indicate 95 percent confidence intervals.

**Use of Coronary Angiography According to Cohort**

The distribution of patients according to the ACC–AHA class (Fig. 1) was similar in the two groups, except that the percentage of patients assigned to class III was higher in the fee-for-service group than in the managed-care group ( $P < 0.001$ ). The unadjusted rates of angiography according to the ACC–AHA class are shown in Figure 2A. Among patients assigned to class I, the proportion of patients who underwent angiography was larger in the fee-for-service cohort than in the managed-care cohort (46 percent vs. 37 percent,  $P < 0.001$ ). Thus, the level of underuse was 54 percent and 63 percent for fee-for-service beneficiaries and managed-care enrollees, respectively. The rate of angiography among patients assigned to class III was low (approximately 13 percent in each cohort,  $P = 0.33$ ). The adjusted rates of angiography according to the ACC–AHA class and cohort (Fig. 2B) were similar to the unadjusted rates.

In addition to enrollment in a managed-care plan, increasing age was correlated with the underuse of angiography. Among patients assigned to class I in both groups, the rate of angiography declined with increasing age, but a higher percentage of fee-for-service beneficiaries than managed-care enrollees underwent angiography in each age group (data not shown). The differences between the two cohorts remained after we adjusted for demographic, clinical, and hospital characteristics.

Some patients assigned to class I may have been treated medically, and as a result, the need for angiography may have been delayed. However, on the basis of additional data collected by the General Accounting Office for managed-care enrollees and on the basis of Medicare claims for fee-for-service beneficiaries, the rate of angiography remained lower in the managed-care group than in the fee-for-service group 60 days after admission (35 percent vs. 43 percent,  $P < 0.001$ ). In addition, among patients as-

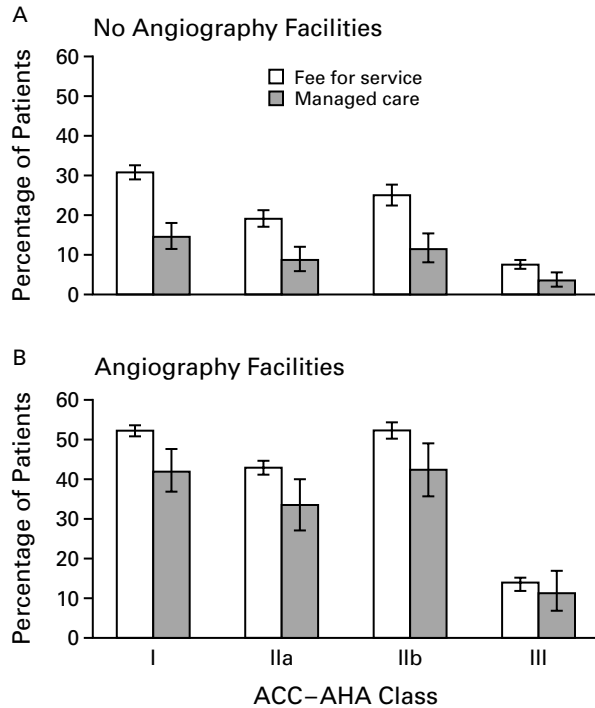


**Figure 2.** Rate of Coronary Angiography According to the American College of Cardiology–American Heart Association (ACC–AHA) Class and Type of Medicare Coverage.

Panel A shows unadjusted rates, and Panel B shows rates adjusted for demographic and clinical characteristics of the patients and characteristics of the hospitals. The I bars indicate 95 percent confidence intervals.

signed to class I who underwent angiography, a larger proportion of fee-for-service beneficiaries than managed-care enrollees underwent a revascularization procedure during the 60 days after admission (64 percent vs. 58 percent,  $P < 0.001$ ).

Figure 3 shows the adjusted rates of angiography, stratified according to the availability of coronary angiography at the admitting hospital. Within each ACC–AHA class and in both cohorts, angiography was performed less often among patients admitted to hospitals without angiography facilities (Fig. 3A) than among those admitted to hospitals with such facilities (Fig. 3B), but in both types of hospitals, fee-for-service beneficiaries underwent angiography more often than managed-care enrollees ( $P < 0.05$  for all comparisons except that involving patients assigned to class III who were admitted to hospitals with angiography facilities). At hospitals without angiography facilities, the rate of angiography among managed-care enrollees assigned to each ACC–AHA class was about half the rate among fee-for-service beneficiaries assigned to the same class (Fig. 3A), and the level of underuse was substantial (85 percent and 69 percent, respectively).



**Figure 3.** Adjusted Rates of Coronary Angiography among Patients Admitted to a Hospital without Angiography Facilities (Panel A) and among Those Admitted to a Hospital with Angiography Facilities (Panel B). The I bars indicate 95 percent confidence intervals. ACC-AHA denotes American College of Cardiology-American Heart Association.

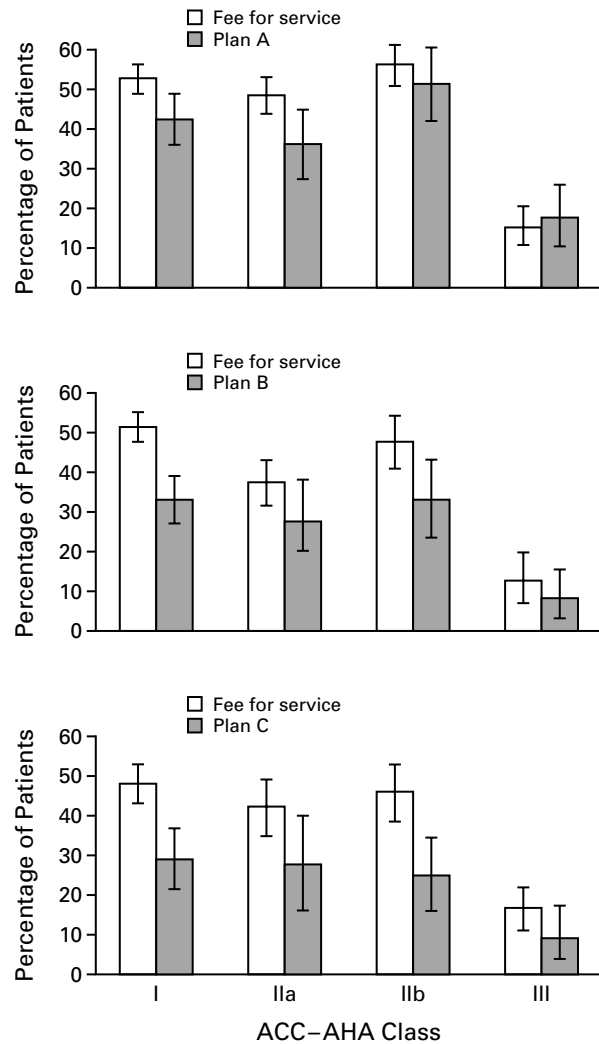
**Use of Angiography in Members of Specific Plans**

The percentage of managed-care enrollees who underwent angiography varied according to the particular plan (Fig. 4). Rates of underuse ranged from 57 percent (in Plan A) to 71 percent (in Plan C). Rates of inappropriate use ranged from 9 percent (in Plans B and C) to 18 percent (in Plan A).

The pattern of differences in utilization between the fee-for-service group and the managed-care group was similar in the three plans (Fig. 4). For patients with class I indications, the rate of angiography was higher among fee-for-service beneficiaries than among managed-care enrollees. For patients with class III indications, the rates were similar in the two groups.

**DISCUSSION**

We compared the use of angiography after acute myocardial infarction in Medicare beneficiaries with traditional fee-for-service coverage and in those enrolled in managed-care risk plans. Except for patients in whom angiography would not have been expected to be effective (those with ACC-AHA class III indications), fee-for-service beneficiaries were more



**Figure 4.** Adjusted Rates of Coronary Angiography among Members of Managed-Care Plans A (Top Panel), B (Middle Panel), and C (Bottom Panel) and among Fee-for-Service Beneficiaries in the Same Hospital Service Areas. The I bars indicate 95 percent confidence intervals. ACC-AHA denotes American College of Cardiology-American Heart Association.

likely than managed-care enrollees to undergo coronary angiography. Other investigators have also documented that invasive cardiac procedures are performed less often in managed-care enrollees than in fee-for-service beneficiaries.<sup>7-12</sup> Our study of Medicare beneficiaries showed that the lower rate of use among managed-care enrollees was due in part to the failure to perform angiography in patients in whom it was indicated according to the ACC-AHA guidelines (class I indications). Nevertheless, the percentage of patients with class I indications who did not undergo angiography was high in both cohorts.

Our results are similar to those reported by Sada et al.<sup>11</sup> in a study of patients under the age of 65 years who had been hospitalized for acute myocardial infarction. They found that among patients in whom angiography was indicated, those with fee-for-service coverage were more likely to undergo angiography than were enrollees in health maintenance organizations. However, Sada et al.<sup>11</sup> studied only patients treated at hospitals with angiography facilities. In both of the cohorts in our study, the level of use according to the ACC–AHA class was much higher among patients initially admitted to a hospital with angiography facilities than among those admitted to a hospital without such facilities. Most striking was the level of underuse among patients admitted to a hospital without angiography facilities: 69 percent and 85 percent for fee-for-service beneficiaries and managed-care enrollees, respectively.

Comparisons of the rate of angiography among members of a specific plan and fee-for-service beneficiaries in the same hospital service area revealed that among the patients assigned to class I, the fee-for-service beneficiaries underwent angiography more often than did the managed-care enrollees; among patients assigned to class III, the rates were similar in the two groups. The rate of use according to the ACC–AHA class varied among the plans; given the limited number of plans available for analysis, however, we cannot draw conclusions about differences in practice according to the type of managed-care plan.

This study has several potential limitations. First, the generalizability of the findings may be limited. We studied Medicare beneficiaries treated in only seven states. However, these states account for over 70 percent of Medicare beneficiaries enrolled in managed-care plans. Second, incomplete, inconsistent, or miscoded clinical data may have resulted in erroneous classification of patients according to the ACC–AHA class. However, the quality-control procedures used as part of the CCP probably prevented most instances of misclassification, and any errors in classification were probably distributed similarly between the fee-for-service group and the managed-care group. We acknowledge that the rate of underuse was high; the overall rate of angiography was only 37 percent among the fee-for-service beneficiaries and 32 percent among the managed-care enrollees. Considering that more than 40 percent of the patients in each cohort were assigned to class I, underuse could have been reduced significantly only if the patients assigned to class I had undergone angiography and those assigned to other classes had not — an unlikely scenario.

In conclusion, in situations in which angiography is considered to be useful, it was used less often in managed-care enrollees than in fee-for-service beneficiaries. This was true whether the patients were admitted to hospitals with angiography facilities or without them and even when we compared angiography

rates among Medicare beneficiaries enrolled in specific plans with the rates among fee-for-service beneficiaries in the same hospital service areas. Nevertheless, the level of underuse was high in both cohorts, suggesting that there is room for improving the care of elderly patients with acute myocardial infarction, regardless of the type of Medicare coverage, and especially those initially admitted to hospitals without angiography facilities.

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The views expressed in this article are those of the authors and not necessarily those of the General Accounting Office.

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## APPENDIX

The following criteria were used for assigning patients to an ACC–AHA class:

**Criteria for class I** — The presence of one or both of the following: an episode of myocardial ischemia (manifested as chest pain after arrival at the hospital, ischemia on a stress test, or both) and persistent hemodynamic instability (manifested as cardiogenic shock on arrival at the hospital or during the hospital stay, hypotension during the hospital stay, congestive heart failure or pulmonary edema with an ejection fraction of 40 percent or less, or a combination of these findings)

**Criteria for class IIa** — The absence of class I indications and the presence of one or more of the following: an ejection fraction of 40 percent or less, prior revascularization, and congestive heart failure or pulmonary edema

**Criterion for class IIb** — The presence of myocardial infarction without complications

**Criteria for class III** — The presence of one or more of the following: hepatic failure, metastatic cancer, terminal illness, a do-not-resuscitate order in force at the time of admission, and decubitate or decerebrate posturing or a lack of motor response

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