

## Special Articles

## OUTCOME OF ACUTE MYOCARDIAL INFARCTION ACCORDING TO THE SPECIALTY OF THE ADMITTING PHYSICIAN

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**ABSTRACT**

**Background** In order to limit costs, health care organizations in the United States are shifting medical care from specialists to primary care physicians. Although primary care physicians provide less resource-intensive care, there is little information concerning the effects of this strategy on outcomes.

**Methods** We examined mortality according to the specialty of the admitting physician among 8241 Medicare patients who were hospitalized for acute myocardial infarction in four states during a seven-month period in 1992. Proportional-hazards regression models were used to examine survival up to one year after the myocardial infarction. To determine the generalizability of our findings, we also examined insurance claims and survival data for all 220,535 patients for whom there were Medicare claims for hospital care for acute myocardial infarction in 1992.

**Results** After adjustment for characteristics of the patients and hospitals, patients who were admitted to the hospital by a cardiologist were 12 percent less likely to die within one year than those admitted by a primary care physician ( $P < 0.001$ ). Cardiologists also had the highest rate of use of cardiac procedures and medications, including medications (such as thrombolytic agents and beta-blockers) that are associated with improved survival.

**Conclusions** Health care strategies that shift the care of elderly patients with myocardial infarction from cardiologists to primary care physicians lower rates of use of resources (and potentially lower costs), but they may also cause decreased survival. Additional information is needed to elucidate how primary care physicians and specialists should interact in the care of severely ill patients. (N Engl J Med 1996;335:1880-7.)

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**A** COMMON strategy of health care organizations in the United States to reduce use of medical services is to increase the use of primary care physicians and limit access to specialists.<sup>1,2</sup> Because primary care physicians have been found to provide care that is less resource-intensive, this fundamental shift in referral patterns should lower medical costs.<sup>3</sup>

Whether the increasing shift to primary care for

purposes of saving money may also involve trade-offs with respect to outcomes has not been adequately studied, particularly in the case of acutely ill patients. Studies have suggested that replacing subspecialty care with primary care for patients with acute cardiac illnesses may lead to worse outcomes for patients.<sup>4,5</sup> Ayanian and colleagues<sup>5</sup> reported that family practitioners and internists were less aware of or less certain about effective and life-saving drugs for the treatment of acute myocardial infarction than were cardiologists. In order to examine further the relation between the outcomes of patients with myocardial infarction and the type of physicians (primary care or specialist) who provide their care, we studied detailed clinical data from the Cooperative Cardiovascular Project (CCP) on 8241 Medicare patients hospitalized for acute myocardial infarction during the period June through December 1992.<sup>6,7</sup> To evaluate the generalizability of our findings, we also examined insurance claims and survival data for all 220,535 patients with Medicare claims for hospital care for acute myocardial infarction at any time in 1992.

**METHODS****Sources of Data****The CCP**

The CCP collected data abstracted from the charts of all Medicare patients who were discharged from the hospital with a diagnosis of acute myocardial infarction in Alabama, Connecticut, Iowa, and Wisconsin between June 1, 1992, and February 28, 1993.<sup>6,7</sup> Information collected for each patient included patient identifiers (health insurance claims numbers), dates of hospitalization, demographic characteristics, history of chest pain, Killip class, use of medications, presence or absence of contraindications to therapy, results of electrocardiography, results of tests for cardiac enzymes, results of invasive and noninvasive cardiac tests, occurrence and nature of complications, treatment, and vital status.

**Medicare National Claims History File**

The Medicare National Claims History File for 1992 includes claims under both Part A (for hospital care) and Part B (for phy-

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sicians' services and outpatient care) for approximately 95 percent of all hospitalizations for acute myocardial infarction among patients over the age of 65 years in the United States during the study period.<sup>8</sup> Part A claims 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. Part B claims contain demographic data and limited clinical information from bills from physicians and bills for outpatient care, including the patient's health insurance claims number, the service or procedure provided, according to Current Procedural Terminology (CPT) codes, and the UPIN of the physician submitting the bill.<sup>9</sup>

### Patients

For the principal analyses, we selected all patients listed by the CCP who had a confirmed acute myocardial infarction (according to clinical criteria) for whom there were records in the 1992 Medicare files (matched according to the patient's health insurance claims number and the dates of hospitalization). As in previous studies, the criteria for myocardial infarction included either a serum creatine kinase MB index above 3 percent or any two of the following three criteria: chest pain; a doubling of the serum creatine kinase concentration or a lactate dehydrogenase isoenzyme 1 concentration greater than the concentration of lactate dehydrogenase isoenzyme 2; and evidence of acute myocardial infarction on electrocardiography.<sup>6,7</sup> For secondary analyses, all 1992 Medicare hospital claims involving acute myocardial infarction in a patient over 65 years of age were selected according to previously described methods.<sup>10</sup> To avoid counting patients more than once, we analyzed only the first hospitalization for any given patient.

### Identification of Physicians' Specialties

The admitting physician was considered to be the physician who submitted the Medicare Part B claim for initial hospital care (CPT 99221-3). For patients without a claim for initial hospital care, the physician listed on the bill from the earliest hospital day for critical care services (CPT 99291-2) or subsequent hospital care (CPT 99231-3) was used in the analyses of physicians' specialties. Each physician's specialty was identified by linking his or her UPIN with a directory of physician-reported specialties maintained by the Health Care Financing Administration. As a check on the sensitivity of our findings to the method used to identify the physician's specialty, we repeated all the analyses using the attending physician listed in Medicare Part A claims from 1992. For patients who were transferred between hospitals before discharge, the attending physician identified on the first hospital's claim was used in the analyses of physicians' specialties.

### Statistical Analysis

The primary analysis examined survival of patients listed in the CCP up to one year after acute myocardial infarction according to their physicians' specialties. The physician's specialty was classified as primary care (for those in internal medicine, family medicine, or general practice), cardiology, or "other" (for physicians with other medical specialties, surgical specialties, or missing, incomplete, or unmatched UPINs). We used Cox proportional-hazards regression models to determine the prognostic importance of the physician's specialty, according to the difference in the log-likelihood chi-square between models that included the physician's specialty and those that did not.<sup>11</sup>

Adjustment for imbalances in patients' characteristics was performed by adding the component variables from a previously published model of mortality due to acute myocardial infarction, developed by the Global Utilization of Streptokinase and Tissue Plasminogen Activator for Occluded Coronary Arteries (GUSTO) investigators, to the proportional-hazards models.<sup>12</sup> The variables from the GUSTO model included age, systolic blood pressure at admission, pulse, location of the myocardial infarction, Killip class,

height, weight, history of infarction, history of bypass surgery, smoking status, and the presence or absence of diabetes, hypertension, and cerebrovascular disease. Additional models adjusted for characteristics of the hospitals (availability of coronary angiography, angioplasty, or bypass surgery at the admitting hospital and urban or rural location in relation to federally designated Metropolitan Statistical Areas).<sup>13</sup> Mortality in the Medicare cohort was also examined with adjustment for hospital characteristics and data relevant to the severity of illness from the Medicare files, including age, sex, race, location of the myocardial infarction, and Charlson comorbidity score.<sup>14</sup> All analyses of data from the CCP and Medicare files were repeated after we reclassified the physicians' specialties on the basis of the attending physician listed in Medicare Part A claims. Since these results did not alter our conclusions, only the analyses of data on admitting physicians are presented.

## RESULTS

### Characteristics of the Patients

A total of 220,535 patients were identified in the 1992 Medicare files as having had an acute myocardial infarction; the admitting physician was identified from the Medicare Part B claim for 182,747 of these patients, and the attending physician was identified from the Medicare Part A claim for 216,703 patients. We identified a subgroup of 8241 patients for whom there were CCP data who met the clinical criteria for acute myocardial infarction. The distributions of patients according to the specialty of the admitting physician in the CCP and Medicare cohorts are shown in Tables 1 and 2, respectively.

### Demographic Characteristics

The mean age of the CCP cohort was 76.4 years; 50 percent were women; 94.3 percent were white, 5.1 percent were black, and 0.6 percent were of other or unknown race. Demographic information according to the specialty of the admitting physician is summarized in Table 1 for the CCP cohort and in Table 2 for the Medicare cohort. As compared with patients admitted by physicians in other specialties, patients admitted by cardiologists were approximately two years younger and were less likely to be female. The racial composition of the specialty categories was similar. Patients admitted by cardiologists were more likely to be admitted to urban hospitals and hospitals in which coronary angiography, angioplasty, and bypass surgery were available. Although the Medicare cohort was slightly older than the CCP cohort and had larger proportions of women and blacks, the variation in age, sex, and race according to the specialty of the admitting physician followed a similar pattern among the subgroups in the two cohorts.

### Severity of Illness

According to the CCP data, patients admitted by cardiologists were more likely than others to have had a previous myocardial infarction, to have undergone coronary bypass surgery, to have an anterior myocardial infarction, and to have lower blood pressure on admission — all factors associated with a

**TABLE 1. DEMOGRAPHIC CHARACTERISTICS AND INDICATORS OF THE SEVERITY OF ILLNESS AMONG PATIENTS IN THE COOPERATIVE CARDIOVASCULAR PROJECT DATA BASE, ACCORDING TO THE SPECIALTY OF THE ADMITTING PHYSICIAN.**

VARIABLE	CARDIOLOGY (N=2140)	INTERNAL MEDICINE (N=3086)	FAMILY MEDICINE (N=1819)	GENERAL PRACTICE (N=321)	OTHER OR UNKNOWN (N=875)	TOTAL (N=8241)	P VALUE*
<b>Patients</b>							
Age (yr)							<0.01
Mean	75	77	77	78	75	76	
Interquartile range	70-80	71-82	72-83	70-81	70-80	71-82	
Female sex (%)	43.5	53.1	53.0	53.9	47.7	50.0	<0.01
Race (%)							0.08
White	93.8	94.1	95.7	94.0	93.0	94.3	
Black	5.5	5.4	3.8	5.6	5.7	5.1	
Other	0.7	0.5	0.6	0.4	1.3	0.6	
Infarct location (%)							
Anterior	27.8	22.3	19.0	19.6	22.9	23.0	<0.01
Inferior	30.6	22.6	21.6	26.5	24.9	24.8	<0.01
Killip class (%)							<0.01
1	55.4	51.7	54.7	52.7	55.8	53.8	
2	17.6	17.0	17.2	15.9	14.1	16.8	
3	26.0	30.1	27.4	29.9	27.9	28.2	
4	1.0	1.3	0.7	1.6	2.3	1.2	
Prior bypass surgery (%)	15.1	9.2	8.5	10.3	11.3	10.8	<0.01
Prior myocardial infarction (%)	30.1	25.5	26.0	25.9	27.1	27.0	<0.01
Systolic blood pressure at admission (mm Hg)							<0.01
Mean	96	98	98	99	93	97	
Interquartile range	85-110	87-112	87-114	86-116	85-110	86-112	
Height (cm)							<0.01
Mean	169	167	167	167	169	168	
Interquartile range	160-178	160-176	160-175	158-175	163-177	160-175	
Weight (kg)							<0.01
Mean	75	73	72	75	74	74	
Interquartile range	64-85	61-82	61-82	62-85	62-85	62-84	
Diabetes (%)	24.9	28.0	27.8	24.9	27.0	26.9	0.1
Hypertension (%)	51.3	53.9	49.4	42.7	47.8	51.1	<0.01
Cerebrovascular disease (%)	11.7	15.0	14.9	15.0	12.7	13.9	<0.01
Current cigarette use (%)	15.2	12.5	11.8	13.1	14.3	13.3	0.02
Past cigarette use (%)	29.6	25.6	22.4	19.6	26.7	25.8	<0.01
Predicted 30-day mortality (%)†	18.3	20.1	20.2	19.9	20.5	19.7	<0.01
<b>Hospitals</b>							
Rural location (%)	10.9	26.3	53.3	48.3	29.8	29.5	<0.01
Angiography available (%)	87.5	74.0	46.7	50.2	69.2	70.1	<0.01
Angioplasty available (%)	61.9	40.9	23.1	27.4	38.4	41.6	<0.01
Bypass surgery available (%)	59.3	39.7	21.9	26.8	37.0	40.1	<0.01

\*P values for the comparison of study groups were obtained by the likelihood-ratio chi-square test (in the case of categorical variables) and by analysis of variance (in the case of continuous variables).

†Predicted 30-day mortality was based on the GUSTO mortality model.<sup>12</sup>

greater risk of death. Several variables indicated that patients admitted by primary care physicians had more severe disease than those admitted by cardiologists, notably the lower proportions of inferior myocardial infarctions, greater rates of diabetes and cerebrovascular disease, and lower proportions of patients in Killip class I. When we combined characteristics indicating severity of illness according to the method used by the GUSTO investigators to model mortality due to myocardial infarction, patients admitted by cardiologists had a significantly lower predicted 30-day mortality.<sup>12</sup>

#### Medications, Cardiac Procedures, and Length of Stay

As previously reported, the rate of use of medications to prolong survival among the patients in the

CCP data set was substantially lower than would be supported by evidence from randomized trials available at the time of the study.<sup>6,7</sup> The use of drug therapies is shown in Table 3, according to the physician's specialty. Approximately 6 percent more patients admitted by cardiologists were considered to be eligible for thrombolytic therapy than was the case for patients admitted by other physicians. Patients admitted by cardiologists were more likely than the other patients to be treated with all the medications we studied except angiotensin-converting-enzyme inhibitors. When patients who were receiving these therapies before admission were excluded, the patterns were similar.

Data on the use of procedures and the length of the hospital stay are summarized in Tables 4 and 5.

**OUTCOME OF ACUTE MYOCARDIAL INFARCTION ACCORDING TO THE SPECIALTY OF THE ADMITTING PHYSICIAN**

**TABLE 2.** DEMOGRAPHIC CHARACTERISTICS AND INDICATORS OF THE SEVERITY OF ILLNESS AMONG PATIENTS IN THE MEDICARE INSURANCE-CLAIMS DATA BASE, ACCORDING TO THE SPECIALTY OF THE ADMITTING PHYSICIAN.\*

VARIABLE	CARDIOLOGY (N=61,809)	INTERNAL MEDICINE (N=69,144)	FAMILY MEDICINE (N=27,765)	GENERAL PRACTICE (N=13,114)	OTHER OR UNKNOWN (N=48,703)	TOTAL (N=220,535)
Age (yr)						
Mean	75	77	78	78	77	77
Interquartile range	70–80	71–83	71–83	72–83	70–82	71–82
Female sex (%)	45.6	54.4	53.8	54.0	47.7	50.4
Race (%)						
White	91.6	91.1	92.5	91.2	88.8	90.9
Black	5.3	6.5	5.4	6.4	7.6	6.2
Other	3.1	2.4	2.1	2.4	3.6	2.9
Infarct location (%)						
Anterior	26.5	24.0	25.8	26.3	24.4	25.2
Inferior	30.3	23.8	25.1	25.1	24.3	26.0
Non-Q-wave	22.0	25.8	22.9	20.9	23.9	23.6
Charlson comorbidity index	0.7 (0–1)	0.8 (0–1)	0.8 (0–1)	0.7 (0–1)	0.8 (0–1)	0.8 (0–1)

\*P<0.01 for all comparisons of study groups by the likelihood-ratio chi-square test (in the case of categorical variables) or by analysis of variance (in the case of continuous variables).

**TABLE 3.** USE OF DRUG THERAPY AMONG PATIENTS LISTED IN THE COOPERATIVE CARDIOVASCULAR PROJECT DATA BASE, ACCORDING TO THE SPECIALTY OF THE ADMITTING PHYSICIAN.

THERAPY*	CARDIOLOGY	INTERNAL MEDICINE	FAMILY MEDICINE	GENERAL PRACTICE	OTHER OR UNKNOWN	TOTAL
	percent of patients					
Thrombolytic therapy						
Used	15.8	9.2	7.7	7.2	11.2	10.7
Patient considered eligible	65.9	60.2	59.1	59.8	62.3	61.6
Beta-blockers	52.4	39.7	35.4	36.1	39.4	41.9
Aspirin	85.0	79.3	74.0	68.9	75.8	78.8
Angiotensin-converting-enzyme inhibitors	36.4	37.2	35.9	33.0	34.4	36.3
Heparin	79.3	64.2	57.2	54.5	69.3	66.7
Nitroglycerin	96.2	93.3	90.4	88.8	89.9	92.9
Calcium-channel blockers	59.1	57.8	51.8	52.3	55.9	56.4

\*For angiotensin-converting-enzyme inhibitors, P=0.4 for the comparison of study groups by the likelihood-ratio chi-square test. P<0.01 for all other comparisons.

In both cohorts, patients admitted by cardiologists underwent substantially more coronary-angiography and revascularization procedures than patients admitted by physicians in the other specialties. The proportion of patients who were identified as having clinically significant left main or three-vessel coronary artery disease was similar among all the specialties. Patients admitted by cardiologists were also more likely to undergo other procedures, including stress testing, nuclear imaging, Holter monitoring, and echocardiography.

The mean length of stay was 8.5 days for the CCP cohort and 8.7 days for the Medicare cohort. Length of stay was shortest for patients admitted by family medicine practitioners in both the CCP and Medicare cohorts. When we excluded the patients who

underwent coronary revascularization before discharge, patients admitted by physicians in family medicine continued to have the shortest hospital stays, whereas those admitted by physicians specializing in cardiology and internal medicine had the longest stays.

**Survival**

Crude in-hospital, 30-day, and 1-year mortality rates for patients in the CCP data set were 14.7 percent, 19.7 percent, and 32.8 percent, respectively (Table 6). Patients admitted by cardiologists had the lowest mortality for each period. In the Medicare cohort, mortality was higher for all the periods, and patients admitted by cardiologists had the lowest crude mortality. Figure 1 shows the hazard ratios and 95

**TABLE 4.** USE OF PROCEDURES AND LENGTH OF THE HOSPITAL STAY AMONG PATIENTS IN THE COOPERATIVE CARDIOVASCULAR PROJECT DATA BASE, ACCORDING TO THE SPECIALTY OF THE ADMITTING PHYSICIAN.\*

VARIABLE	CARDIOLOGY	INTERNAL MEDICINE	FAMILY MEDICINE	GENERAL PRACTICE	OTHER OR UNKNOWN	TOTAL
<b>In-hospital procedures (% of patients)</b>						
Coronary angiography	49.0	30.4	17.5	21.2	35.8	32.6
Left main or 3-vessel CAD detected	16.9	10.1	5.8	5.1	12.1	10.9
Left main or 3-vessel CAD detected in patient undergoing angiography†	34.4	33.2	32.9	24.1	33.7	33.5
Any revascularization	22.4	10.1	6.8	8.7	14.2	13.2
Coronary angioplasty	13.4	6.7	3.7	6.2	8.2	7.9
Bypass surgery	10.3	4.6	3.4	2.8	7.0	6.0
Stress testing	13.7	11.3	8.6	9.0	11.0	11.2
Nuclear imaging	18.6	13.3	6.8	8.4	14.5	13.2
Holter monitoring	2.5	2.1	1.3	0.6	1.0	1.8
Echocardiography	55.1	51.8	43.2	39.9	49.6	50.1
<b>Length of stay (mean no. of days)</b>						
All patients	9.3	8.6	7.3	8.0	8.5	8.5
Patients not undergoing revascularization	8.2	8.0	6.7	7.8	7.6	7.7
Patients undergoing revascularization in hospital‡	13.1	13.6	15.0	11.0	13.8	13.5

\*CAD denotes coronary artery disease. P values for all comparisons of study groups were obtained by the likelihood-ratio chi-square test (in the case of categorical variables) or by analysis of variance (in the case of continuous variables). P<0.01 for all comparisons, except as noted below.

†Only the patients who underwent angiography were included in this analysis. P=0.6 for the comparison between study groups.

‡P=0.2 for the comparison between study groups.

**TABLE 5.** USE OF PROCEDURES AND LENGTH OF THE HOSPITAL STAY AMONG PATIENTS IN THE MEDICARE INSURANCE-CLAIMS DATA BASE, ACCORDING TO THE SPECIALTY OF THE ADMITTING PHYSICIAN.\*

VARIABLE	CARDIOLOGY	INTERNAL MEDICINE	FAMILY MEDICINE	GENERAL PRACTICE	OTHER OR UNKNOWN	TOTAL
<b>In-hospital procedures (% of patients)</b>						
Coronary angiography within 60 days	48.9	29.6	27.6	27.2	29.8	34.6
Any revascularization						
In hospital	18.5	7.4	5.1	5.5	10.2	10.7
Within 60 days	31.7	18.2	17.2	16.7	18.2	21.7
Coronary angioplasty within 60 days	18.3	9.6	8.9	9.1	9.6	11.9
Bypass surgery within 60 days	14.7	9.1	8.7	8.1	9.3	10.6
<b>Length of stay (mean no. of days)</b>						
All patients	8.7	8.8	7.6	7.8	9.6	8.7
Patients not undergoing revascularization	7.9	8.4	7.4	7.5	9.0	8.2
Patients undergoing revascularization in hospital	12.3	13.7	12.4	12.6	14.3	13.0

\*P<0.001 for all comparisons of study groups by the likelihood-ratio chi-square test (in the case of categorical variables) or by analysis of variance (in the case of continuous variables).

percent confidence intervals for one-year survival in the CCP cohort according to specialty, after adjustment for the characteristics of the patients (severity of illness as indicated by the CCP data) and the hospitals (availability of coronary angiography, angioplasty, or bypass surgery and urban or rural location), with patients admitted by internists as the reference category.

After adjustment for patients' characteristics, patients admitted by cardiologists had significantly bet-

ter one-year survival than those admitted by physicians in all the primary care specialties (hazard ratio, 0.87; P<0.001). The survival advantage for cardiology persisted and remained significant after we adjusted for hospitals' characteristics (hazard ratio, 0.88; P<0.001). Adjusted rates of one-year survival did not differ significantly among the primary care specialties. Admission by a cardiologist was also found to be significantly associated with better sur-

**TABLE 6.** CRUDE MORTALITY IN THE COOPERATIVE CARDIOVASCULAR PROJECT (CCP) AND MEDICARE COHORTS, ACCORDING TO THE SPECIALTY OF THE ADMITTING PHYSICIAN.\*

VARIABLE	CARDIOLOGY	INTERNAL MEDICINE	FAMILY MEDICINE	GENERAL PRACTICE	OTHER OR UNKNOWN	TOTAL
percent of patients						
In-hospital mortality						
CCP	12.4	15.8	13.4	14.6	19.1	14.7
Medicare	15.2	18.1	19.3	20.5	21.8	18.4
30-Day mortality						
CCP	15.7	20.3	20.4	22.1	24.7	19.7
Medicare	19.6	23.3	25.5	27.4	27.0	23.6
1-Year mortality						
CCP	27.3	34.0	34.7	36.1	36.9	32.8
Medicare	30.4	37.5	39.3	40.4	40.2	36.5

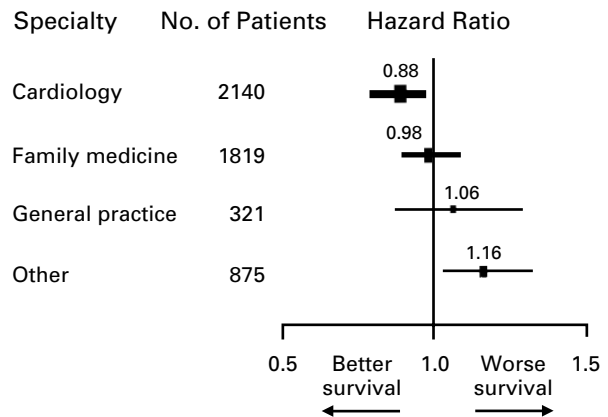
\*P<0.01 for the comparison of study groups by the likelihood-ratio chi-square test.

vival in the Medicare cohort, after adjustment for severity-of-illness measures recorded in the Medicare file and for characteristics of the hospitals. These relations persisted when the specialty of the attending physician listed in Medicare Part A claims was used to reclassify patients.

**DISCUSSION**

In this study, we found that cardiologists used more resources and achieved better outcomes than physicians in other specialties in caring for elderly patients with acute myocardial infarction. Patients admitted by cardiologists underwent more diagnostic and therapeutic procedures, had longer hospital stays, and received more medications to treat ischemic heart disease than patients treated by physicians in other specialties. After adjustment for characteristics of the patients and hospitals, patients admitted by cardiologists were also more likely to survive for at least one year after myocardial infarction. These findings suggest that health care strategies that shift the care of elderly patients with myocardial infarction from cardiologists to primary care physicians are likely to lead not only to lower rates of use of resources (hence, potentially lower costs), but also to decreased survival.

There are at least three possible explanations for these findings. The first is that specific aspects of care by cardiologists were responsible for the better outcomes. Cardiologists have a narrower clinical focus, and therefore more experience with patients who have coronary disease, and more time to devote to continuing education relevant to the treatment of such disease. Because of this additional training and experience, cardiologists would be expected to be more familiar with the diagnosis and management of complications of acute myocardial infarction, such as complete heart block or mitral-valve rup-



**Figure 1.** Hazard Ratios for Adjusted One-Year Mortality among Patients with Acute Myocardial Infarction in the Cooperative Cardiovascular Project Cohort, According to the Specialty of the Admitting Physician.

The bars indicate the 95 percent confidence intervals. The hazard ratios have been adjusted for indicators of the severity of illness; the availability of facilities for coronary angiography, angioplasty, or bypass surgery at the hospital; and urban or rural hospital location. Patients admitted by physicians specializing in internal medicine served as the reference category.

ture, and to select treatments associated with better survival.

That we found differences among the specialties in the use of medications and coronary-revascularization procedures, aspects of care that are associated with outcome, supports this hypothesis. Cardiologists were more likely than other physicians to treat patients with thrombolytic agents, beta-blockers, aspirin, nitrates, and heparin — medications that are associated with improved survival.<sup>5,15-17</sup> Differences in survival attributable to these medications would be expected to become apparent during the initial

hospitalization and to continue through the year after discharge. Cardiologists were not more likely to treat patients with angiotensin-converting-enzyme inhibitors, but studies demonstrating a survival benefit associated with the use of these drugs after myocardial infarction were not published until September 1992, about halfway through the study period.<sup>18</sup>

Differences in the use of coronary angiography and revascularization procedures may also have contributed to improved survival, although the survival benefits would be expected to become most apparent after one year of follow-up. Coronary revascularization, particularly bypass surgery, has been associated with improved survival in randomized trials predominantly involving younger, male patients treated 10 to 20 years before the study period.<sup>19</sup> The use of bypass surgery in these early trials was associated with an initial increase in mortality, followed by an improvement in survival that became most apparent three to seven years after the procedure. With higher rates of coronary angiography and a similar proportion of patients found to have left main or three-vessel coronary disease, cardiologists in this study identified more patients whose coronary anatomy indicated that revascularization would improve survival (Table 4). They also treated more patients with coronary revascularization. If the survival pattern among the older patients in this study was similar to those observed in the randomized trials, the cardiologists' greater use of coronary revascularization would be expected to result in increased short-term mortality, with improved survival beyond one year of follow-up.

A second potential explanation for the lower mortality among patients admitted by cardiologists may be provided by factors other than care by a cardiologist that are associated with admission to a cardiology service. Such factors may include admission to a hospital that cares for large numbers of patients with acute myocardial infarction, the presence of emergency room physicians who are likely to recognize acute myocardial infarction and initiate early treatment, and the on-site availability of procedures for the management of complications, such as coronary angioplasty or bypass surgery. Adjustment for the availability of these procedures at the admitting hospital did not account for observed differences, and neither did whether the hospital was located in an urban area, a crude marker of available technology. Because of the correlation between the physician's specialty and these characteristics of the hospital, the influence of these two factors is difficult to separate, and it is most likely that both factors improved outcomes.

A third explanation is that differences in severity of illness led to the lower mortality among patients admitted by cardiologists. When we assessed severity of illness according to the GUSTO model, patients ad-

mitted by cardiologists were predicted to have 1.6 to 1.8 percent lower mortality at 30 days than patients admitted by primary care physicians. However, the observed differences in survival among the specialties were much greater than could be explained by baseline measures of the severity of illness. Although it is possible that additional characteristics indicating severity of illness were not measured, the clinical variables for which we did adjust accounted for more than 90 percent of the prognostic information available from the base-line evaluation of patients with myocardial infarction in the GUSTO study.<sup>12</sup>

In the 41,000-patient GUSTO study, age provided nearly half the prognostic information (30-day mortality) according to the global chi-square statistic, and age, systolic blood pressure, Killip class, heart rate, and location of the infarct together provided approximately 90 percent of the total prognostic information available among 16 clinical predictors examined. Similarly, age, systolic blood pressure, Killip class, heart rate, and weight provided 90 percent of the total prognostic information derived from patients' characteristics in that study. It is unlikely that additional measures of the severity of illness would explain the differences in mortality among patients treated by physicians in different specialties.

#### Use of the UPIN to Identify the Physician's Specialty

We chose to examine the outcome of acute myocardial infarction according to the physician's specialty in 1992, since 1992 was the first year when the UPIN was required for Medicare reimbursement. A potential problem with our methods is that the specialty was reported by the physician, rather than by a certification board. The study by Ayanian and colleagues found that the majority of physicians who identify themselves as specializing in family medicine, internal medicine, and cardiology were board-certified (89 percent, 78 percent, and 85 percent, respectively).<sup>5</sup> Moreover, in identifying physicians who provide superior care to patients with acute myocardial infarction, board-certification status may not be as important as the specialty reported by the physician. Physicians who are not board-certified but who identify themselves as practicing a particular specialty may have enhanced skills due to their experience with their area of interest. The importance of board certification cannot be determined from this study.

In order to avoid bias related to the referral of patients to other services, we classified patients according to the specialty of the admitting physician. We also examined the data according to the specialty of the attending physician listed in claims for in-hospital care; this physician is defined as "the clinician who is primarily and largely responsible for the care of the patient from the beginning of the hospital episode," according to the Uniform Hospital Discharge Data

Set definitions.<sup>20</sup> For 82 percent of patients, the specialty of the physician was the same in both sources. For the remaining 18 percent, the specialty of the physician responsible for admission and the physician responsible for the majority of the patient's care were probably different, and the latter was selected as the attending physician. Analyses according to the specialty of the attending physician yielded the same findings — specifically, that receiving care from a cardiologist was associated with lower mortality.

**Conclusions**

We found that patients with acute myocardial infarction who were admitted to the hospital by a cardiologist had a better rate of survival than those admitted by primary care physicians. We also identified one of the potential mechanisms contributing to the survival advantage: the greater use of therapies associated with increased survival. Care by a cardiologist was also associated with the use of more resources, particularly cardiac procedures. This study provides national data on patients over the age of 65 in 1992, and our results should be generalizable to more recent cohorts, at least in this age group. Although the results of this study alone cannot be used to justify a policy requiring that all patients with acute myocardial infarction be cared for by cardiologists, our findings indicate a critical need to define better the differences between specialty and primary care and the effects of those differences on outcomes.

Supported by grants (HS-08805 and HS-06503) from the Agency for Health Care Policy and Research, Rockville, Md.

*We are indebted to David B. Pryor, M.D., for directing the analyses of the data from the Cooperative Cardiovascular Project as part of the Ischemic Heart Disease Patient Outcome Research Team of the Agency for Health Care Policy and Research and to James P. Nolan, M.D., and Caroline M. Sherman, M.B.A., for their helpful comments on the manuscript.*

**REFERENCES**

1. Cohen JJ. Transforming the size and composition of the physician work force to meet the demands of health care reform. *N Engl J Med* 1993;329:1810-2.

2. Clement DG, Retchin SM, Brown RS, Stegall MH. Access and outcomes of elderly patients enrolled in managed care. *JAMA* 1994;271:1487-92. [Erratum, *JAMA* 1994;272:276.]

3. Greenfield S, Nelson EC, Zubkoff M, et al. Variations in resource utilization among medical specialties and systems of care: results from the medical outcomes study. *JAMA* 1992;267:1624-30.

4. Schreiber TL, Elkhatib A, Grines CL, O'Neill WW. Cardiologist versus internist management of patients with unstable angina: treatment patterns and outcomes. *J Am Coll Cardiol* 1995;26:577-82.

5. Ayanian JZ, Hauptman PJ, Guadagnoli E, Antman EM, Pashos CL, McNeil BJ. Knowledge and practices of generalist and specialist physicians regarding drug therapy for acute myocardial infarction. *N Engl J Med* 1994;331:1136-42.

6. Ellerbeck EF, Jencks SF, Radford MJ, et al. Quality of care for Medicare patients with acute myocardial infarction: a four-state pilot study from the Cooperative Cardiovascular Project. *JAMA* 1995;273:1509-14.

7. Krumholz HM, Radford MJ, Ellerbeck EF, et al. Aspirin in the treatment of acute myocardial infarction in elderly Medicare beneficiaries: patterns of use and outcomes. *Circulation* 1995;92:2841-7.

8. May DS, Kelly JJ, Mendlein JM, Garbe PL. Surveillance of major causes of hospitalization among the elderly, 1988. *MMWR CDC Surveill Summ* 1991;40(SS-1):7-21.

9. Physicians' current procedural terminology 1994. Chicago: American Medical Association, 1994.

10. Jollis JG, Peterson ED, DeLong ER, et al. The relation between the volume of coronary angioplasty procedures at hospitals treating Medicare beneficiaries and short-term mortality. *N Engl J Med* 1994;331:1625-9.

11. Cox DR. Regression models and life-tables. *J R Stat Soc [B]* 1972;34:187-220.

12. Lee KL, Woodlief LH, Topol EJ, et al. Predictors of 30-day mortality in the era of reperfusion for acute myocardial infarction: results from an international trial of 41,021 patients. *Circulation* 1995;91:1659-68.

13. Bureau of the Census. State and metropolitan area data book, 1991. Washington, D.C.: Government Printing Office, 1991.

14. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987;40:373-83.

15. Yusuf S, Wittes J, Friedman L. Overview of results of randomized clinical trials in heart disease. I. Treatment following myocardial infarction. *JAMA* 1988;260:2088-93.

16. ISIS-2 (Second International Study of Infarct Survival) Collaborative Group. Randomised trial of intravenous streptokinase, oral aspirin, both, or neither among 17 187 cases of suspected acute myocardial infarction: ISIS-2. *Lancet* 1988;2:349-60.

17. Gruppo Italiano per lo Studio della Streptochinasi nell'Infarto Miocardico (GISSI). Long-term effects of intravenous thrombolysis in acute myocardial infarction: final report of the GISSI study. *Lancet* 1987;2:871-4.

18. Pfeffer MA, Braunwald E, Moyé LA, et al. Effect of captopril on mortality and morbidity in patients with left ventricular dysfunction after myocardial infarction: results of the survival and ventricular enlargement trial. *N Engl J Med* 1992;327:669-77.

19. Yusuf S, Zucker D, Peduzzi P, et al. Effect of coronary artery bypass graft surgery on survival: overview of 10-year results from randomised trials by the Coronary Artery Bypass Graft Surgery Trialists Collaboration. *Lancet* 1994;344:563-70. [Erratum, *Lancet* 1994;344:1446.]

20. Iezzoni LI. Data sources and implications: administrative data bases. In: Iezzoni LI, ed. Risk adjustment for measuring health care outcomes. Ann Arbor, Mich.: Health Administration Press, 1994:122-75.

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