

Special Article

SPECIALTY OF AMBULATORY CARE PHYSICIANS AND MORTALITY
AMONG ELDERLY PATIENTS AFTER MYOCARDIAL INFARCTION

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ABSTRACT

Background The outcome after myocardial infarction may be influenced by the type of physician providing ambulatory care.

Methods We studied 35,520 patients 65 years of age or older who were hospitalized for myocardial infarction in seven states during 1994 and 1995 and who survived for at least three months after discharge. From Medicare claims, we identified ambulatory visits to cardiologists, internists, and family practitioners. Using propensity scores to adjust for demographic, clinical, and hospital characteristics, we analyzed treatment and mortality at two years among patients matched according to their estimated propensity to receive care from a cardiologist within three months after discharge.

Results As compared with patients who saw only an internist or a family practitioner in the three months after discharge, patients who saw a cardiologist were younger, were more likely to be white, were more likely to be male, had fewer coexisting conditions, and were more likely to have undergone invasive cardiac procedures while hospitalized ($P < 0.01$ for all comparisons). Patients who saw a cardiologist were more likely to undergo cardiac procedures and rehabilitation after discharge. Patients who saw a cardiologist had a lower two-year mortality rate than matched patients who saw only an internist or a family practitioner (14.6 percent vs. 18.3 percent, $P < 0.001$). Patients who saw both a cardiologist and an internist or a family practitioner had a lower mortality rate than matched patients who saw only a cardiologist (11.1 percent vs. 12.1 percent, $P = 0.02$).

Conclusions Ambulatory visits to cardiologists were associated with greater use of cardiac procedures and decreased mortality after myocardial infarction. Concurrent care by an internist or a family practitioner was associated with a further reduction in mortality. (N Engl J Med 2002;347:1678-86.)

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EFFECTIVE ambulatory care after acute myocardial infarction can identify related complications, such as chest pain or depression, and promote appropriate therapies for the prevention of recurrent myocardial infarction.¹ High-quality ambulatory care can also reduce or prevent complications of coexisting illnesses, such as diabetes mellitus.

Previous studies have assessed patients' treatment and mortality after myocardial infarction according to the specialties of the physicians who provided hospital care.²⁻⁴ In some studies, patients of cardiologists had lower adjusted mortality than patients of internists or family practitioners,⁵⁻⁸ but in other studies, differences in mortality were smaller in magnitude and were largely explained by the characteristics of the patients and the hospitals.⁹⁻¹² The use of cardiac drugs that are effective in reducing the risk of cardiovascular events may increase when both cardiologists and generalist physicians participate in the care of patients with myocardial infarction.^{9,13} Building on these hospital-based studies of physicians' specialties and outcomes, we evaluated the relation between ambulatory care and mortality among elderly patients after myocardial infarction.

METHODS

Study Population

Patients were identified from the Cooperative Cardiovascular Project, a federal evaluation of approximately 225,000 elderly Medicare beneficiaries who were hospitalized in the United States with a principal diagnosis of acute myocardial infarction during 1994 and 1995.^{14,15} We studied patients in seven states (California, Florida, Massachusetts, New York, Ohio, Pennsylvania, and Texas). The study was approved by the Committee on Human Studies of Harvard Medical School.

We identified 52,064 patients 65 to 84 years of age with fee-for-service Medicare coverage who were discharged alive after a clinically confirmed myocardial infarction.¹⁴ We excluded 4146 patients who died within three months after discharge, 3115 who had metastatic cancer or a do-not-resuscitate order, 411 who were enrolled in

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a health maintenance organization within three months after discharge, 773 who resided in nursing homes, and 648 who lacked Medicare Part B coverage for physicians' care. Of the remaining 42,971 patients, we excluded 7341 without at least one claim for an ambulatory visit to a cardiologist, family practitioner, or internist within three months after discharge and 110 for whom clinical data were incomplete, yielding a study cohort of 35,520 patients.

Sources of Data

Trained abstractors reviewed hospital records using a standardized instrument with excellent reliability to ascertain patients' demographic characteristics, coexisting illnesses, cardiac complications, test results, cardiovascular medications, and treatment involving coronary angiography, angioplasty, and bypass surgery.¹⁴ The use of these coronary procedures within three months after discharge was determined from Medicare Part A and hospital outpatient claims. Hospitals' teaching status, ownership, and location and the availability of coronary angiography and revascularization procedures were determined from Medicare and American Hospital Association data. Patients' vital status during the two years after discharge was determined from Medicare enrollment files.

The use of cardiovascular medications was assessed approximately 18 months after discharge by a telephone survey of 3271 patients (with a response rate of 78 percent), as previously described.¹⁶ Patients also reported whether they underwent cardiac rehabilitation or exercise testing or received advice on diet or exercise from the physicians who provided ambulatory care.

Ambulatory visits to physicians were determined from Medicare Part B and hospital outpatient claims available for 18 months after discharge. For each patient, we identified all paid claims with Current Procedural Terminology (CPT-4) codes for office-based evaluation and management services (codes 99201 through 99215 and 99241 through 99245).¹⁷ The physician's specialty was listed on the Part B claims. We determined a physician's specialty for hospital outpatient claims by linking with the Medicare physicians' registry. To determine whether a patient had received care from a cardiologist while hospitalized, we analyzed Part B claims for attending or consultative services (codes 99217 through 99239 and 99251 through 99275).

Statistical Analysis

Our primary analysis was a comparison between patients who had at least one office visit with a cardiologist during the three months after discharge (with or without a visit to an internist or a family practitioner) and those who had at least one visit with an internist or a family practitioner but no visit with a cardiologist. Because of marked differences in observed characteristics between patients in these two groups, we analyzed patients closely matched for the likelihood that they would receive ambulatory cardiology care.^{18,19} As demonstrated in other observational studies of health outcomes,²⁰⁻²³ propensity-score methods are a powerful tool for comparing groups that are similar in observed characteristics without specifying the relation between confounders and outcomes, as is required by more traditional multivariate-regression approaches.²⁴

We fitted a logistic-regression model that predicted whether a patient would visit a cardiologist within three months after discharge as a function of 36 variables, including the patient's demographic and clinical characteristics, care provided in the hospital, medications at discharge, and hospital characteristics (Table 1).²⁵ Each patient who did not see a cardiologist was matched with a patient who did see a cardiologist with the closest estimated propensity on the logit scale within a specified range (≤ 0.6 of the pooled standard deviation of estimated logits) to reduce differences between treatment groups by at least 90 percent.²⁶ Using identical methods among patients with at least one cardiology visit, we matched patients who did not see an internist or a family practitioner with patients who did. Among survey respondents, we also matched patients according to physician's specialty in a similar manner.

In descriptive analyses of unmatched and matched cohorts, we compared patients' characteristics according to the specialty of the physicians who provided ambulatory care. In the unmatched cohort, we analyzed the numbers of visits (median and interquartile range) according to physician's specialty within 3 months after discharge and during the subsequent 15 months. In the matched cohort, we assessed the use of coronary angiography, angioplasty, and bypass surgery within three months after discharge. Among matched survey respondents, we analyzed the rates of receipt of aspirin, beta-blockers, angiotensin-converting-enzyme inhibitors, cholesterol-lowering drugs, cardiac rehabilitation, exercise testing, and dietary or exercise counseling.

We analyzed the unadjusted mortality rates at two years after discharge according to physician's specialty in the unmatched cohort using Pearson's chi-square test. We used McNemar's test for paired data to compare two-year mortality among all matched patients and according to quintiles of propensity to visit a cardiologist, and we compared risk ratios across quintiles with the Mantel-Haenszel test. We assessed Kaplan-Meier survival curves with log-rank tests in the matched samples. We also performed a sensitivity analysis to evaluate whether unmeasured characteristics of patients might explain differences in mortality associated with the physician's specialty.²⁷ We report two-tailed tests of significance for all analyses using SAS statistical software.

RESULTS

Characteristics of the Patients

Table 1 shows the characteristics of the initial study cohort of 35,520 patients before and after they were matched according to their propensity to visit a cardiologist within three months after discharge. In the sample of unmatched patients, 24,656 patients (69.4 percent) had at least one visit with a cardiologist. The likelihood of visiting a cardiologist was significantly greater for younger, male, and white patients than for older, female, and black patients and for patients in California, Florida, or Texas than for those in New York, Ohio, or Pennsylvania.

In comparison with those who saw only a generalist physician, patients who had ambulatory visits with cardiologists were less likely to have had major coexisting conditions or impaired mobility before admission to the hospital for myocardial infarction. These patients were also more likely to have been admitted to nonrural hospitals or major teaching hospitals that offered invasive coronary procedures. While hospitalized, they were less likely to have had congestive heart failure or renal insufficiency but were more likely to have had recurrent chest pain, cardiac arrest, or cardiogenic shock. These patients were much more likely to have been treated by a cardiologist while hospitalized and to have received thrombolytic therapy, coronary angiography, angioplasty, or bypass surgery. They were also more likely to have been discharged taking aspirin, beta-blockers, or cholesterol-lowering drugs but were less likely to have been discharged taking angiotensin-converting-enzyme inhibitors or to have been transferred to a skilled-nursing facility after discharge.

Of the 10,864 patients who visited an internist or a family practitioner but not a cardiologist within

TABLE 1. CHARACTERISTICS OF PATIENTS WHO RECEIVED AMBULATORY CARDIOLOGY CARE WITHIN THREE MONTHS AFTER MYOCARDIAL INFARCTION AND PATIENTS WHO DID NOT.*

CHARACTERISTIC	UNMATCHED PATIENTS			MATCHED PATIENTS†		
	CARDIOLOGIST (N=24,656)	GENERALIST ONLY (N=10,864)	P VALUE	CARDIOLOGIST (N=10,199)	GENERALIST ONLY (N=10,199)	P VALUE
Mean age (yr)	73.2	74.4	<0.001	74.1	74.2	0.24
Male sex (%)	59.6	50.9	<0.001	51.9	52.0	0.87
Race or ethnic group (%)			<0.001			0.77
White	92.1	89.8		90.1	90.2	
Black	3.3	5.5		5.3	5.1	
Hispanic	3.6	3.8		3.6	3.7	
Other	1.0	0.9		1.0	1.0	
State (%)			<0.001			0.96
California	15.0	8.3		8.8	8.8	
Florida	19.1	17.7		18.2	18.1	
Massachusetts	7.3	7.4		7.5	7.6	
New York	14.2	16.8		17.2	16.8	
Ohio	12.7	15.2		14.7	14.9	
Pennsylvania	17.4	23.0		22.3	22.1	
Texas	14.3	11.6		11.3	11.7	
Conditions before admission (%)						
Myocardial infarction	29.2	29.2	0.99	29.8	29.1	0.30
Angina	55.4	51.8	<0.001	53.1	52.7	0.49
Congestive heart failure	13.3	18.5	<0.001	17.4	17.7	0.56
Stroke	9.2	12.9	<0.001	12.1	12.1	0.98
Peripheral vascular disease	10.3	11.3	0.005	11.0	11.1	0.95
Hypertension	62.2	64.8	<0.001	65.8	64.6	0.15
Diabetes mellitus	28.7	34.2	<0.001	33.7	33.5	0.74
Chronic obstructive pulmonary disease	17.9	22.8	<0.001	21.6	21.7	0.76
Impaired mobility	19.1	24.6	<0.001	23.6	23.4	0.69
Dementia	1.3	2.9	<0.001	2.2	2.3	0.48
Rural hospital (%)	6.0	11.7	<0.001	9.4	10.0	0.12
Hospital teaching status (%)			<0.001			0.19
Major teaching	14.5	12.3		13.3	12.9	
Other teaching	30.8	32.0		33.3	32.4	
Nonteaching	54.7	55.7		53.4	54.7	
Hospital ownership (%)			<0.001			0.91
Not-for-profit	78.6	80.5		80.5	80.4	
For-profit	12.7	10.7		10.6	10.9	
Public	8.7	8.8		8.8	8.7	
Coronary procedures available on site (%)			<0.001			0.08
Coronary angiography and bypass surgery	57.6	46.9		50.0	48.7	
Coronary angiography only	21.9	22.1		22.5	22.5	
None	20.5	30.9		27.5	28.9	
Clinical complications in hospital (%)						
Cardiac arrest	6.6	4.9	<0.001	5.1	5.0	0.77
Cardiogenic shock	3.4	2.6	<0.001	2.7	2.7	0.80
Congestive heart failure	35.9	40.5	<0.001	40.4	39.6	0.22
Recurrent chest pain	32.1	28.6	<0.001	29.9	29.2	0.28
Serum creatinine ≥ 2.0 mg/dl (≥ 176.8 μ mol/liter)	8.6	11.4	<0.001	10.9	10.8	0.84
Serum albumin < 3.0 g/dl	3.1	3.9	<0.001	3.7	3.8	0.85
Care provided in hospital (%)						
Attending or consultant cardiologist	77.5	56.9	<0.001	60.6	60.3	0.66
Thrombolytic therapy	23.2	16.3	<0.001	17.5	17.2	0.63
Echocardiography	62.0	63.3	0.02	63.8	63.6	0.80
Stress test	17.2	17.4	0.70	17.7	17.8	0.87
Coronary angiography	48.7	33.6	<0.001	36.7	35.6	0.10
Coronary angioplasty	17.8	10.7	<0.001	11.9	11.3	0.20
Coronary bypass surgery	10.0	6.5	<0.001	7.2	6.9	0.30
Care at discharge from hospital (%)						
Aspirin	66.5	64.6	<0.001	64.9	64.9	0.93
Beta-blockers	43.3	41.0	<0.001	41.8	41.7	0.78
Angiotensin-converting-enzyme inhibitors	28.6	32.9	<0.001	32.5	32.1	0.63
Cholesterol-lowering drugs	8.8	7.2	<0.001	7.5	7.4	0.91
Transfer to skilled-nursing facility	1.7	3.9	<0.001	3.0	3.1	0.84

*A generalist physician was defined as an internist or a family practitioner. All P values are based on the Pearson chi-square test, except for that for age, which is based on Student's t-test. Because of rounding, percentages may not total 100.

†Patients were matched according to their estimated propensity to visit a cardiologist within three months after discharge.

90 days after discharge, 10,199 (93.9 percent) were matched with a similar patient who visited a cardiologist. After matching, no statistically significant differences were noted between the characteristics of patients who visited a cardiologist and those who did not (Table 1). Unlike the substantial differences between unmatched patients in these two groups, the differences in the unmatched analysis between the 10,871 patients (44.1 percent) who visited only a cardiologist and the 13,785 patients (55.9 percent) who also visited an internist or a family practitioner were much smaller and often nonsignificant (Table 2). Among patients who visited only a cardiologist, 10,415 (95.8 percent) were matched with a similar patient who also visited an internist or a family practitioner; no significant differences were noted between matched patients in these two groups.

Office Visits

The initial patterns of ambulatory care were largely maintained over time. In the unmatched cohort,

most patients who saw only a cardiologist during the 3 months after discharge (median, two visits; interquartile range, one to three) continued to see a cardiologist in the subsequent 15 months (median, three visits; interquartile range, two to six); 42 percent saw an internist or a family practitioner in this later period, but only 22 percent had three or more visits. Most patients who saw only an internist or a family practitioner in the first 3 months after discharge (median, three visits; interquartile range, two to four) continued to do so in the subsequent 15 months (median, five visits; interquartile range, three to nine); 22 percent saw a cardiologist in the later period, but only 8 percent had three or more cardiology visits. Most patients who initially saw both an internist or a family practitioner (median, two visits; interquartile range, one to three) and a cardiologist (median, two visits; interquartile range, one to two) continued to see both types of physician, although they had more subsequent visits with internists or family practitioners (median, five visits; interquartile range, two to eight) than with

TABLE 2. SELECTED CHARACTERISTICS OF PATIENTS WHO RECEIVED AMBULATORY CARDIOLOGY CARE WITH OR WITHOUT CARE FROM A GENERALIST PHYSICIAN WITHIN THREE MONTHS AFTER MYOCARDIAL INFARCTION.*

CHARACTERISTIC	UNMATCHED PATIENTS			MATCHED PATIENTS†		
	CARDIOLOGIST AND GENERALIST (N=13,785)		P VALUE	CARDIOLOGIST AND GENERALIST (N=10,415)		P VALUE
	CARDIOLOGIST ONLY (N=10,871)	CARDIOLOGIST ONLY (N=10,415)				
Mean age (yr)	73.2	73.2	0.23	73.2	73.2	0.69
Male sex (%)	57.2	62.6	<0.001	61.4	61.6	0.78
White race (%)	92.8	91.3	<0.001	91.8	91.9	0.88
Conditions before admission (%)						
Myocardial infarction	27.5	31.4	<0.001	30.0	30.3	0.60
Congestive heart failure	13.3	13.2	0.70	13.2	13.1	0.97
Hypertension	64.2	59.6	<0.001	60.9	60.6	0.58
Diabetes mellitus	31.9	24.5	<0.001	25.9	25.4	0.44
Chronic obstructive pulmonary disease	18.8	16.9	<0.001	17.2	17.3	0.90
Hospital characteristics (%)						
Major teaching hospital	13.9	15.3	0.003	15.0	15.1	0.82
Coronary angioplasty and bypass surgery available on site	57.5	57.6	0.92	57.8	57.8	0.99
Clinical complications in hospital (%)						
Congestive heart failure	36.0	35.6	0.50	35.4	35.7	0.65
Recurrent chest pain	32.9	31.1	<0.001	31.3	31.5	0.82
Serum creatinine ≥2.0 mg/dl (≥176.8 μmol/liter)	8.3	9.0	0.04	8.6	8.8	0.86
Care provided in hospital (%)						
Attending or consultant cardiologist	77.3	77.8	0.38	77.8	77.6	0.80
Thrombolytic therapy	23.0	23.6	0.27	23.7	23.7	0.99
Coronary angiography	48.3	49.2	0.14	49.3	49.1	0.80
Care at discharge from hospital (%)						
Aspirin	66.6	66.5	0.95	66.7	66.7	0.96
Beta-blockers	43.8	42.8	0.11	43.3	43.2	0.83
Cholesterol-lowering drugs	9.0	8.5	0.15	8.5	8.5	0.96

*A generalist physician was defined as an internist or a family practitioner. All P values are based on the Pearson chi-square test, except for that for age, which is based on Student's t-test.

†Patients were matched according to their estimated propensity to visit both a cardiologist and a generalist physician within three months after discharge.

cardiologists (median, two visits; interquartile range, one to four).

Cardiac Care

In the full matched cohort, the use of coronary angiography, angioplasty, and bypass graft surgery within three months after discharge was significantly more frequent among patients who visited a cardiologist than among those who did not visit a cardiologist (Table 3). In contrast, among those who saw a cardiologist, those who also saw a generalist were significantly more likely to undergo coronary angiography, but there was no difference in the likelihood of undergoing angioplasty or bypass surgery between those who did and those who did not see a generalist. Among matched survey respondents, patients who saw a cardiologist were more likely than those who did not to report having received cardiac rehabilitation or undergone exercise testing after discharge. The use of cardiovascular drugs and reports of receiving dietary or exercise advice 18 months after discharge did not differ according to the physician's specialty.

Mortality

The two-year mortality rate in the unmatched cohort was 11.8 percent for those who saw a cardiologist in the first three months after discharge and 19.1 percent for those who saw only an internist or a family practitioner ($P < 0.001$). This absolute difference in

mortality of 7.3 percent was reduced by half, to 3.7 percent (14.6 percent vs. 18.3 percent), after matching but remained statistically significant ($P < 0.001$). The Kaplan–Meier survival curves for this matched cohort are depicted in Figure 1A. When the matched cohort was divided into quintiles according to the propensity to visit a cardiologist, the absolute reduction in mortality associated with cardiology care was greatest among patients with the least propensity to visit a cardiologist (Fig. 2). The relative reduction in mortality did not differ significantly among quintiles, with values of 0.76, 0.79, 0.86, 0.85, and 0.80 for the relative risk of death in quintiles one (lowest propensity) to five (highest propensity), respectively, as compared with patients who did not visit a cardiologist ($P = 0.66$).

In a sensitivity analysis, we estimated the effect of controlling for an unmeasured factor, such as a high-school degree, that could have been present in two thirds of the cohort, could have increased the likelihood of visiting a cardiologist by 10 percent, and could have been associated with a 40 percent reduction in mortality.²⁸ Adjusting for such a factor would reduce the absolute difference in mortality between patients who did and who did not visit a cardiologist from 3.7 percent to 2.8 percent, but this difference would remain significant. For this difference to become nonsignificant, an unobserved variable would have to be associated with a 40 percent relative in-

TABLE 3. CARE RECEIVED AFTER MYOCARDIAL INFARCTION AMONG MATCHED PATIENTS ACCORDING TO TYPE OF PHYSICIAN PROVIDING AMBULATORY CARE WITHIN THREE MONTHS AFTER DISCHARGE.*

TYPE OF CARE	GENERALIST			CARDIOLOGIST		
	CARDIOLOGIST	ONLY	P VALUE	AND GENERALIST	CARDIOLOGIST ONLY	P VALUE
Coronary procedures within 3 mo (%)†						
Angiography	26.8	16.7	<0.001	25.9	24.0	0.002
Angioplasty	11.8	6.9	<0.001	12.7	12.1	0.17
Bypass graft surgery	11.9	7.0	<0.001	11.7	11.4	0.53
Ambulatory care reported at 18 mo (%)‡						
Cardiac rehabilitation	36.4	29.0	0.03	39.8	33.8	0.06
Exercise-tolerance testing	61.4	52.8	0.003	64.0	64.4	0.88
Dietary counseling	57.4	58.8	0.65	61.4	60.0	0.62
Exercise counseling	63.1	60.8	0.45	65.9	64.7	0.65
Cardiovascular drugs reported at 18 mo (%)‡						
Aspirin	72.1	72.1	1.00	76.8	74.3	0.30
Beta-blockers	40.8	40.0	0.77	39.7	38.8	0.73
Angiotensin-converting-enzyme inhibitors	31.6	31.3	0.85	28.6	30.8	0.39
Cholesterol-lowering drugs	23.2	20.8	0.33	28.4	27.3	0.66

*All P values are based on the chi-square test.

†Data are from Medicare Part A and hospital outpatient claims for matched cohorts, as described in the Methods section. The numbers of subjects were 10,199, 10,199, 10,415, and 10,415, respectively, for the cardiologist, generalist-only, cardiologist-and-generalist, and cardiologist-only groups.

‡Data are from matched cohorts of survey respondents, as described in the Methods section. The numbers of respondents were 595, 595, 642, and 642, respectively, for the cardiologist, generalist-only, cardiologist-and-generalist, and cardiologist-only groups.

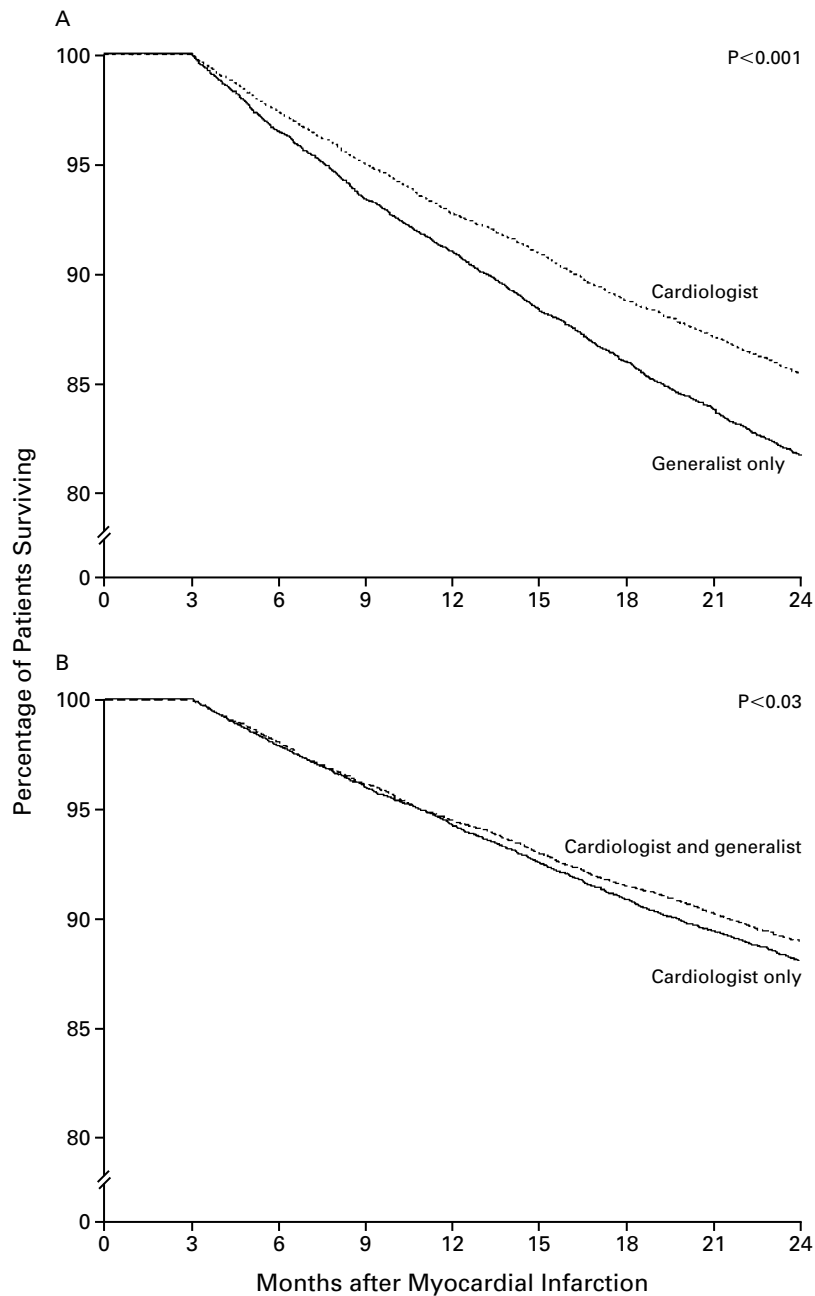


Figure 1. Kaplan–Meier Survival Curves for Two Years after Myocardial Infarction, According to the Types of Physicians Providing Ambulatory Care during the Initial Three Months.

Panel A shows a matched cohort of 10,199 patients who saw a cardiologist and 10,199 patients who saw an internist or a family practitioner, but not a cardiologist. Panel B shows a matched cohort of 10,415 patients who saw both a cardiologist and an internist or a family practitioner and 10,415 patients who saw only a cardiologist. P values are derived from log-rank tests. Note expanded scale on the ordinates in both panels.

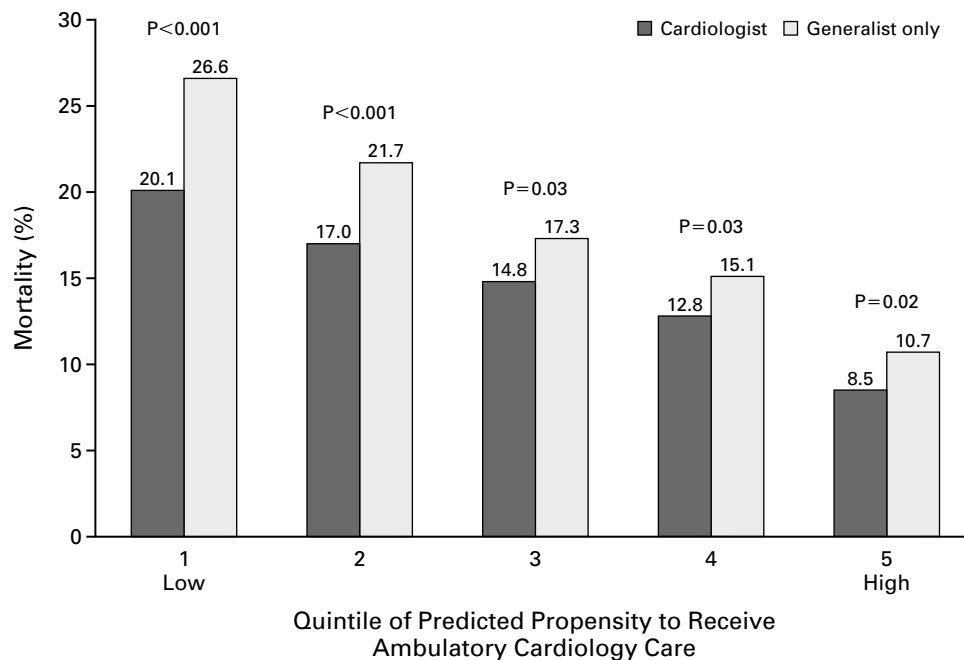


Figure 2. Mortality within Two Years after Myocardial Infarction in a Matched Cohort of 10,199 Patients Who Saw a Cardiologist and 10,199 Patients Who Saw Only an Internist or a Family Practitioner during the Initial Three Months, Stratified According to Quintile of Estimated Propensity to See a Cardiologist.

All P values are based on McNemar's test.

crease in the likelihood of visiting a cardiologist and a 60 percent relative reduction in the two-year mortality rate.

Among patients in the unmatched cohort who visited a cardiologist in the first three months after discharge, the two-year mortality rate was slightly, but not significantly, lower for those who also visited an internist or a family practitioner than for those who did not (11.5 percent vs. 12.2 percent, $P=0.12$). After these two groups of patients were matched according to their propensity to visit an internist or a family practitioner, the difference in the mortality rate was statistically significant (11.1 percent vs. 12.1 percent, $P=0.02$) and was initially apparent about one year after discharge (Fig. 1B). This 1.0 percent absolute difference would be reduced to 0.8 percent and would become nonsignificant if an unobserved variable were associated with a 10 percent relative increase in the rate of concurrent care by cardiologists and generalist physicians and a 25 percent relative reduction in two-year mortality.

DISCUSSION

Among Medicare beneficiaries who were hospitalized in seven states for acute myocardial infarction during 1994 and 1995, the likelihood of visiting a cardiologist within three months after discharge var-

ied markedly according to characteristics of the patient and the hospital. Older patients, women, black patients, patients with major coexisting illnesses, and those admitted to hospitals that did not offer invasive coronary procedures were less likely to visit a cardiologist for subsequent ambulatory care. These results extend those of previous studies that have demonstrated similar differences in patients' access to cardiologists while hospitalized for acute myocardial infarction.^{5,9,11,29} Patients who saw both a cardiologist and an internist or a family practitioner had somewhat higher rates of coexisting illness than those who saw only a cardiologist; these two groups of patients were fairly similar in terms of other characteristics.

When propensity-score methods were used to account for differences in observed characteristics of patients, visits to a cardiologist during the initial three months after discharge were associated with a significant reduction in two-year mortality. The absolute differences in mortality were greatest among patients least likely to visit a cardiologist, a result suggesting that the marginal benefit of improving access to cardiologists could be greatest for these patients. Among patients who saw a cardiologist, two-year mortality was lower for those who also saw an internist or a family practitioner, indicating that concurrent — and, ideally, collaborative — ambulatory care by generalists and

specialists may provide the best prospect for improving outcomes after myocardial infarction.

Two main factors could explain the differences in mortality associated with the specialty of the physician providing ambulatory care after myocardial infarction. First, unobserved variations in patients' severity of illness, socioeconomic status, extent of social support, or adherence to therapy may persist, even after patients are matched closely with regard to numerous observed characteristics. Controlling for an unobserved variable, such as the patient's level of education, in a sensitivity analysis reduced, but did not eliminate, the statistically significant difference in mortality associated with care by a cardiologist. The reduction in mortality associated with concurrent care by both a cardiologist and an internist or a family practitioner was more sensitive to mild residual confounding.

A second possible explanation is that the quality of care after myocardial infarction may be enhanced when cardiologists provide ambulatory care or collaborate with internists or family practitioners.³⁰ Patients who saw a cardiologist were more likely than patients who saw only an internist or a family practitioner to undergo invasive coronary procedures, exercise testing, and cardiac rehabilitation after discharge, which may have contributed to differences in mortality over the ensuing two years. Similarly, mortality may have been further reduced among patients who saw both a cardiologist and an internist or a family practitioner if they received better care for common coexisting conditions, such as diabetes mellitus.

In this study, however, we did not find significantly higher rates of use of effective cardiovascular drugs among patients of cardiologists surveyed in 1996 and 1997. Many patients, regardless of their physician's specialty, were not receiving effective drugs or relevant counseling, suggesting that substantial opportunities exist for both cardiologists and generalist physicians to improve their care. In a subsequent survey conducted during 1999 and 2000, elderly patients who were cared for by a cardiologist were more likely to be taking cholesterol-lowering drugs after myocardial infarction than those treated by an internist or a family practitioner (67 percent vs. 58 percent),³¹ a result consistent with previous research indicating that specialists adopt new cardiovascular drugs more rapidly than generalist physicians.^{32,33}

The strengths of our study include the large and representative cohort, detailed data from hospital records, longitudinal assessment of Medicare claims for ambulatory care, and the use of rigorous propensity-score methods to minimize selection bias in the analysis. Our study also had several limitations. We relied on specialty designations obtained from Medicare data, as has been done in previous studies of myocardial infarction.^{5,10-12,29} These designations may differ some-

what from other sources of specialty information, such as the American Medical Association Physician Masterfile.³⁴ Data on the use of cardiovascular drugs were available for only a sample of patients who completed a telephone survey, and we did not have data on coronary procedures performed more than three months after discharge. We excluded patients enrolled in health maintenance organizations, in which the effects of primary and specialty care may differ from the effects we observed with fee-for-service care. Assessments of office records, which we did not review, would provide additional insights into the quality of ambulatory care after myocardial infarction.

In conclusion, access to cardiologists for ambulatory care after hospitalization for myocardial infarction varied substantially according to characteristics of the patient and the hospital. Ambulatory care by cardiologists was associated with lower mortality among elderly patients, and a further reduction in mortality was noted among patients treated by both cardiologists and internists or family practitioners. Involvement of cardiologists in ambulatory care after myocardial infarction and effective collaboration between cardiologists and generalist physicians have the potential to improve long-term outcomes after myocardial infarction, particularly for patients who are least likely to receive care from cardiologists.

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