A Systematic Review of Studies Comparing Myocardial Infarction Mortality for Generalists and Specialists: Lessons for Research and Health Policy

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Background: **Much of the research comparing specialists and generalists is from studies of patients who had a myocardial infarction. The present study systematically examined this research.**

Methods: **Medline was used to search for all articles published from 1990 to 2003 that compared cardiologists and generalists for adjusted mortality rates of patients with myocardial infarction. From each article identified, information was abstracted on factors that could have influenced the comparisons.**

Results: **The studies consistently found that patients of generalists were at greater risk of mortality from both cardiac and noncardiac risk factors and had higher unadjusted mortality rates. Adjusting for risk factors decreased the differences between cardiologists and generalists. Studies that seemed to do the best job taking into account patient differences had similar adjusted-mortality rates for the cardiologists and generalists. No studies adequately took into account reasons the patient did not have care by a cardiologist, eg, patient preferences, severity of comorbid disease, general health status, or resource availability.**

Conclusions: **Generalists and cardiologists differ substantially with respect to their patients and practice environments. Results comparing patient outcomes by specialty are often influenced by important patient or resource characteristics that were not taken into account. (J Am Board Fam Med 2006; 19:291–302.)**

In the 1990s, managed care proponents heralded the Medical Outcomes Study as proof that outcomes for patients with chronic diseases cared for by generalists were as good as care delivered by more expensive specialists.[1,2] In response to these findings, observational studies were conducted to compare the processes and outcomes of care delivered by specialists and generalists.[3,4]

Many of these studies were conducted on patients with myocardial infarction. This condition was chosen for research because it has an easily measured and important outcome, mortality, that is influenced by the quality of care. Some studies found that outcomes and processes of care are often better for cardiologists than generalists,[3,4] but others found no significant differences.[5–7] Although the authors acknowledged the limitations of observational data in principle, some concluded that specialists provide better care to cardiac patients than generalists because of their more focused training, knowledge, and skills.[8–10] If this explanation is true, it should have important implications for the organization of the health care system.

To evaluate the evidence for the superiority of specialist care, the present study systematically reviewed articles that compared cardiologists and generalists with respect to their patient mortality rates following a myocardial infarction. Previous articles have not examined how details of variation in adjustment variables and patient selection influence the comparisons of generalists and specialists.

Methods

To identify articles that compared specialists and generalists to outcomes following a myocardial in-

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farction, we conducted a Medline search using the MeSH term *Myocardial Infarction*. The search was limited to those studies that included at least one of the following terms in the title, abstract, or MeSH subject heading: specialist, cardiologist, generalist, family physician, family practitioner, primary care physician, noncardiologist, or general internist. We eliminated articles that were written before 1990, did not analyze original data, included children, were not written in English, or made no adjustment for confounding when reporting mortality rates comparing generalists and specialists. Only studies of patients in the United States were reviewed because factors influencing the comparison of specialties probably vary by country.

To determine whether additional studies might have been missed by our search, we reviewed all the references in the articles located. We also discussed this work at 2 international meetings with experts in the field.

From each article, 2 research assistants, who were not aware of the purpose of the study, independently abstracted information in 5 domains that have been suggested as important in the evaluation of observational studies: comparability of subjects, exposure or intervention, measurement of outcomes (mortality), statistical analysis, and sponsor or funding sources.[11] Although some studies compared process measures relating to the management of the patient, we found no studies that evaluated outcomes other than mortality. Discrepancies in the abstracted data were resolved in discussions between the research assistants and one of the authors (PJ). Taking subject factors into account is especially important in primary care patients because of the heterogeneity of this patient group.[12] For this reason, special effort was made to abstract information relevant to confounding that might influence the association of outcome (mortality) and exposure.[13]

To identify potential weaknesses in study design or analysis, we examined each article from a theoretical framework that included factors potentially able to affect either the selection of health care delivery (generalist or cardiologist) or mortality. This framework includes the structure, process, and outcome model that Donabedian used to describe the quality of care.[14] In addition, we added elements from Anderson's Behavioral Model of Health Services Use that considers environmental factors and patient or population factors as contributing to health care service selection and outcomes.[15] A model including these factors is depicted in Figure 1.

Patient factors referred to in the model include those that influence patient risk (socioeconomic status and other demographic variables, cardiac severity, and noncardiac diseases). These factors modify the risk of a bad outcome and, therefore, determine the best treatment and influence patient choices about interventions. Patient factors such as location and preferences for certain interventions influence choices of hospital, physician, and process of care. For example, patients far from urban centers may have delays in care and less access to cardiologists and cardiac resource intensive hospitals.[16]

Hospital factors have been well documented to contribute to mortality based on several contributors, including size of the hospital, volume of patient admissions with myocardial infarction, type of managed care organization, teaching status, and the presence of revascularization facilities.[5,7,17] Physician factors such as board certification, years experience and specialty distribution may also contribute to process of care which in turn influences outcomes.[18]

The intervention, or exposure, tested in the reviewed studies was physician specialty. The outcome measure used for a given specialty was the odds ratio of mortality for this specialty compared with cardiologists. Most studies reported the adjusted odds ratios comparing mortality between cardiologists and other specialists. One study, however, reported the difference in adjusted mortality rates between cardiologists and other specialties. For this study[7] we used a statistical method[19] to compute the adjusted mortality rate for each specialty from the overall observed mortality rate and the differences in mortality rate. The adjusted odds ratios were then computed from the adjusted mortality rates.

To test for heterogeneity across studies of mortality rates for a given specialty, we computed a χ^2 test for 2 by k contingency tables. We tested the difference between 2 odds ratios using the equation $Z = (\ln_1 - \ln_2)/\sqrt{(SE_1^2 + SE_2^2)}$ where Z has a normal distribution with mean zero and variance 1, $\ln_1$ and $\ln_2$ are the logarithms of the 2 odds ratios, and SE_1 and SE_2 are the standard errors of these logarithms. Heterogeneity in odds ratios was tested

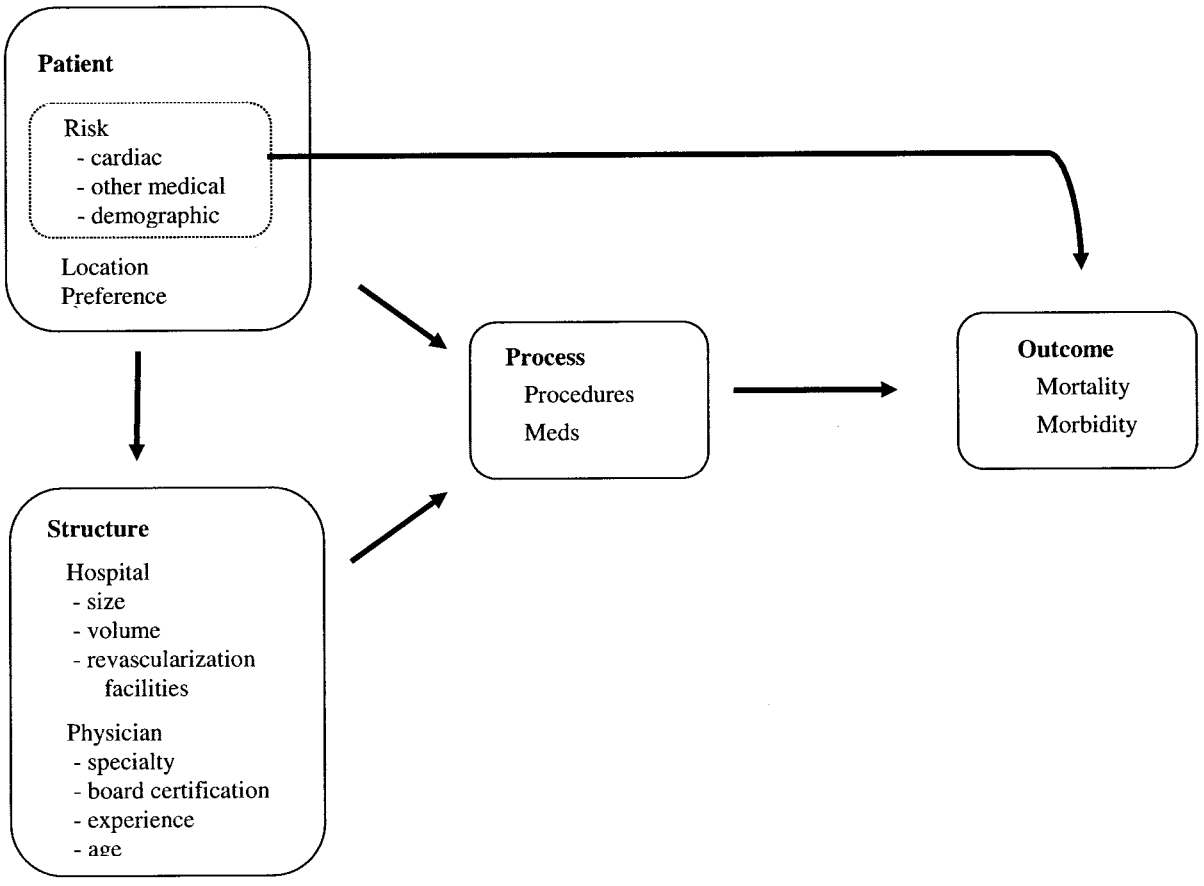

Figure 1. Model of Factors Influencing Patient Outcomes

with the Breslow-Day test for homogeneity at the $P < .05$ level.

Results

Forty-two articles were selected for review; 33 were excluded for the following reasons: 12 were not in the United States, 17 reported no patient mortality results or did not report adjusted mortality rates, 3 were not original research, and one evaluated care in the postmyocardial infarction period. The 11 remaining articles compared mortality rates for generalists to cardiologists before and after adjusting for patient risk factors. Four of these used different components of data from the Cooperative Cardiovascular Project.[20,21] Data collected for the systematic review are shown in Table 1.

There was variation in how physician specialty was identified: one study used only board certified physicians,[5] one study identified the specialty as the admitting physician,[22] and some studies combined noncardiologists into one group.[6,7,9,10] Even when studies identified physicians in the same way, eg, attending physician, this can be variously determined by hospitals as admitting physician, discharge physician, or physician who spent the most time with the patient. The percentage of physicians defined in a given way will depend on the hospitals in the data set.

In Table 2 studies are compared for differences between patients of cardiologists and generalists. For most studies, differences between the generalists and cardiologists for a given factor suggested that generalists' patients were at higher risk. Other risk factors that were not tabulated because they were reported by a few studies, eg, the Atlas severity score[9,10,13,18] or the severity score based on factors in the study entitled "Global Utilization of Streptokinase and Tissue Plasminogen Activator for Occluded Coronary Arteries" (GUSTO)[5–7,22,23] also showed that the patients of the generalists were at higher risk (see Table 3). Two articles included in our analyses[9,13] were not included in this table because they did not show patient risk factor comparisons between specialty groups.

Table 1. Systematic Comparison of Studies

Author and Year	Study Site/Design/ Duration Sample Size	Inclusion Criteria	Exclusion Criteria	Physician Characteristics	Data Abstracted from the Records	Factors Controlled
Chen 2000	USA except the following states: AL, IA, WI, and MN/ retrospective chart review/ 1994–1995/ 109,243 patients	Medicare beneficiaries discharged from the hospital with a diagnosis of MI and chart documentation of either a serum creatine kinase MB index >5%, serum LDH level more than 1.5 times the upper limit of the normal value, or 2 of the 3 following criteria: chest pain, serum creatinine level twice the hospitals normal value, EKG evidence of MI.	Transfer patients (18.0%) Subsequent hospitalization for MI. Those treated by physicians of other specialties, self-declared specialists (not confirmed Board Certified) Patients with terminal illness Missing data	Cardiologists Medical subspecialty General Internists Family practice General practice Confirmed Board Certification	Demographics, clinical history, presenting symptoms, use of medications, treatments, procedures, hospital course, vital status. Dates of death (30 day and 1 year mortality)	Age, systolic BP, Killip class, heart rate, infarct location, previous MI, previous bypass surgery, height, weight, DM, smoking status, HT, cerebrovascular disease. Hospital factors: onsite availability of coronary angiography, angioplasty, bypass surgery, location of hospital, ownership status of hospital, teaching status, Inability to ambulate, urinary incontinence, dementia, admission for nursing home, chronic obstructive pulmonary disease, peripheral vascular disease, liver disease, HIV, or other immunological compromise, trauma within the previous month, serum urea nitrogen level >40 mg/ dL, serum creatinine level >20 mg/dL, serum albumin level <3 mg/dL, hematocrit <30%. Dummy variables were included for missing values.
Frances 2000	USA/retrospective cohort/April 1994 to July 1995/210,996 identified from the Medicare beneficiaries final sample size: 161,558	Creatine kinase MB index ≥5% or an elevated LDH level with LDH-1 ≥ LDH-2, or 2 of 3 criteria: chest pain, creatine kinase ≥ twice the normal value and EKG evidence of AMI. Only first visits were included.	Transfer patients (6.7%) Patients who lacked a confirmed diagnosis of AMI, records not indicating the treating physician, geographical location of their homes	Cardiologist Non-cardiologists Based on UPIN and self-report	Pri.: 30 day and 1 year mortality rates, Sec.: treatment decisions. Med. outcomes: in hospital treatment with thrombolytic therapy, aspirin, beta-blockers, ACE inhibitors, calcium channel blockers. Procedure outcomes: coronary angiography, PTCA, CABG during hospitalization	Demographics, geographic variables, comorbidity, severity variables, hospital volumes variables.

Norcini 2000	Pennsylvania/retrospective chart review/during 1993/ 28,756 patients	Patients who were admitted directly to a hospital for MI (as opposed to those transferred from another acute care hospital)	Transfer patients (20.4%). Patients with "clinical complexity" (cancer, transplant, etc), patients who left the hospital against medical advice, patients of physicians who treated more than 100 patients, patients treated by specialties other than cardiology or primary care, and patients treated at a hospital that closed since 1993 or at a hospital that treated <30 AMI patients in 1993	Cardiologist, Family Medicine and Internal Medicine Based on AMA master file of Board Certification, years of experience since medical school.	Age, gender, cardiac dysrhythmias, cardiogenic shock, cardiomyopathy, conduction disorders, diabetes, dialysis, heart failure, HTN, infarct site, payer, prior CABG, renal failure	Probability of death, availability of advanced cardiac care, hospital location, physician volume, number of years since physician graduated from medical school, physician certification
Frances (Arch) 1999	California/retrospective chart review/April 1994-July 1995/7663 patients	Medicare beneficiaries 65 years and older who had a diagnosis of MI confirmed by either chart review and required a creatine kinase MB index above 0.05 or elevated LDH level with LDH-1 > LDH-2, or 2 of the following criteria: chest pain, creatine kinase MB level at least 2-fold greater than normal, or evidence of AMI on EKG.	Transfer patients (17.2%), those with missing data.	Cardiologist, medical sub-specialists, internists, family practitioners Based on UPIN and self-report	Thrombolytic therapy, aspirin during hospitalization, β adrenergic blocking drugs, ACE inhibitors, calcium channel blockers, at hospitals and at discharge, exercise stress test, EKG, coronary angiography, revascularization procedures, mortality during 1 year.	Patient demographics, comorbidity, severity of illness characteristics on admission, hospital characteristics including volume of admissions for AMI and the availability of revascularization principles
Casale 1998	Pennsylvania during 1993/ retrospective chart review/30,205 patients	Patients who were admitted directly to a hospital for MI (not those transferred from another acute care hospital)	Transfer patients (23%) Under 30 years or over 99 years of age, patients who left the hospital against medical advice, patient with "clinical complexity"(cancer, transplant, etc.) patients of physicians who treated >100 patients, patients treated by specialties other than cardiology or primary care and patients treated at a hospital that closed since 1993 or at a hospital that treated <30 AMI patients in 1993	Cardiologist Primary care Based on self-report	Age, gender, infarct location, Prior CABG<cardiac dysrhythmia, cardiogenic shock, diabetes, cardiomyopathy, conduction disorder, dialysis, renal failure. Patient race not identified	Age, gender, infarct location, Prior CABG<cardiac dysrhythmia, cardiogenic shock, diabetes, cardiomyopathy, conduction disorder, dialysis, renal failure

Table 1. Continued

Author and Year	Study Site/ Design/Duration Sample Size	Inclusion Criteria	Exclusion Criteria	Physician Characteristics	Data Abstracted from the Records	Factors Controlled
Ayanian 1997	Texas USA/ retrospective chart review of Medicare provider analysis. February and May 1990 2087 eligible. 1837 records available.	Patients who underwent coronary angiography within 90 days of initial hospitalization and a random sample of those who did not undergo angiography.	Patients hospitalized during the previous year with a principal diagnosis of acute myocardial infarction, enrolled in HMO, discharged alive in less than 5 days, transferred to another hospital within 2 days without a principal diagnosis of AMI at the receiving hospital	Attending cardiologists Attending generalist Attending generalist with cardiology consultation Based on self-report	Initial hospitals and contiguous transfers to other hospitals, presenting symptoms and vital signs, coexisting illnesses, mobility, results of laboratory tests, EKG findings, major complications, use of cardiac drugs and procedures, mortality rates at 30 days and 1 year after admission. Date of death if applicable	Age, gender, type of infarct, h/o hypertension, heart failure, angina pectoris, diabetes, initial heart rate and systolic BP, impaired mobility and initial creatinine level. History of stroke and time of onset of chest pain until presentation. Hospital characteristics.
Jollis 1996	4 states in USA/ retrospective chart review/ June–December 1992/8241 Medicare beneficiaries	Patients who had a confirmed diagnosis of AMI (criteria for diagnosis of an AMI similar to previous studies)	Subsequent hospitalization for MI. Transferred patients included in analysis but number not listed (assigned to first hospital)	Cardiology, Internal medicine, Family medicine, General practice, other or unknown Based on UPIN and self-report		Age, systolic BP at admission, pulse, location of MI, Killip class, height, weight, h/o infarction, h/o bypass surgery, smoking status, presence or absence of DM, HT, cerebrovascular disease, hospital characteristics, urban or rural site, Charlson comorbidity score

Table 2. Evidence for Lack of Comparability within Studies

	Age	Rural Patients (%)	Heart Failure (%)	Dementia (%)	COPD (%)	Revascular Hospital (%)	Impaired Mobility (%)
Chen et al [5]							
Cardiologists (35%)*	75.3	9†	17	3	16	51	13
Family physicians	77.5	42†	24	8	22	21	23
Frances et al[7]							
Cardiologists (38%)*	73.7	28.3	18.0	3.4	18.6	80.1	17.4
Non-cardiologist	76.6	28.2	26.0	8.8	23.4	55.3	28.0
Norcini et al[18]							
Cardiologists (30%)*	66.1		29.4			41.5	
Family physicians	69.2		35.2			23.4	
Frances et al[23]							
Cardiologists (50%)*	76.6	4.0	19.5	4.5	18.0	75.6	14.2
Family physicians	78.5	11.1	27.7	12.0	23.2	53.7	26.0
Casale et al[10]							
Cardiologists (37%)*	66.1	10.8†				41.2	
Family physicians	70.0	26.7†				25.0	
Ayanian et al[6]							
Cardiologists (36%)*	71.3		32.4			72.8	7.4
Generalists	72.0		31.8			34.9	11.4
Jollis et al[22]							
Cardiologists (26%)*	75.0	10.9†				59.3	
Family physicians	77.0	53.3†				39.7	

* Percentage of patients treated by cardiologist.
† Rural measured by location of hospital.

To reduce confounding due to differences in patient risk, all studies reviewed took into account many characteristics that influenced mortality rates after a myocardial infarction. These characteristics included demographic characteristics (age, race, and gender), cardiac risk factors (the 13 GUSTO-1 variables related to cardiac function), comorbidities (eg, elevated creatinine or BUN), functional status (eg, mobility), and hospital characteristics (revascularization facilities and volume of myocardial infarction patients). Differences among the studies are described in Table 4. None of the studies included the reasons why the patient did not receive care from a cardiologist, eg, they were not candidates for invasive procedures either because of their poor health or personal preferences. The studies

Table 3. Hospitalized Patients of Generalists Compared with Those of Cardiologists*

Demographic factors	↑ age,[7,12,14,18–20] ↑ female,[7,12,14,18–20] ↑ minority,[12,19] ↑ Medicare,[7,14] ↓ commercial insurance[7,14]
Clinical factors	↑ New York Heart Association Class (worse),[12,19] ↑ Killip Class,[12,18] ↑ tachycardia,[12,19] ↓ prior myocardial infarction,[12,18,19] ↑ prior congestive heart failure,[7,12,14,19,20] ↓ cardiogenic shock,[7,14] ↓ cardiac arrest on admission,[12,19] ↓ CABG, and ↓ angioplasty,[7,12,14,19] ↑ GUSTO predicted mortality[18,19]
Cardiac	
Non-cardiac	↑ Prior hypertension,[12,19] ↑ admission from nursing home,[12] ↓ mobility,[12,19,20] ↑ incontinence,[12] ↑ prior stroke,[12,18,19] ↑ diabetes,[12,18–20] ↑ depression,[19] ↑ dementia,[12] ↑ renal,[12,19,20] ↑ liver,[12,19] ↑ obstructive lung disease,[12,19] ↑ anemia,[12,19] ↑ (DNR or terminal patients),[12,19] ↓ ideal candidate for intervention[12,19] ↑ admission severity score[7,14]
Health system: (Hospitals)	↓ size,[19] ↓ MI volume,[7,12,19] ↓ cardiac resources,[12,18,19] ↑ rural,[7,12,14,18,19] ↑ public,[12] ↓ major teaching hospitals[12]

* Arrows indicate that the increase (↑) or decrease (↓) of patient or hospital variables for generalists relative to cardiologists is statistically significant.

Table 4. Study-Specific Factors That Influence Confounding Relative to Other Studies

Study	Reasons Confounding May Be Less	Reasons Confounding May Be Greater
Chen et al[5]	Good measures of comorbidities and functional status. Eliminated patients with terminal illness. Compared board certified physicians.	
Francis et al[7]	Instrumental variable related to hospital distance was used to reduce confounding.	Strong confounding of physician type with patient age.
Norcini et al[18]	Excellent assessment of comorbidities.	No information on functional status or race. Strong confounding of physician type with patient age.
Frances et al[23]	Good measures of comorbidities and functional status.	Generalists patients have very high risk. Patient location not assessed.
Nash et al[9]	Analyzed patients in two age strata. Adjusted for some demographic variables using propensity score.	No information on functional status or race.
Casale et al[10]	Excellent assessment of comorbidities.	No information on functional status or race. Strong confounding of physician type with patient age.
Ayanian et al[6]	Excluded patients 80 or older.	No information on functional status or race.
Nash et al[13]		No information on functional status or race.
Jollis et al[22]		No comorbidity or functional status.

also did not include variables such as socioeconomic status or the severity of the comorbid conditions (eg, cognitive impairment, chronic obstructive lung disease, or cancer). Only the studies by Ayanian et al[6,24] assessed whether cardiologists and generalists collaborated in the care of patients with myocardial infarction.

Unadjusted and adjusted mortality comparisons of generalists and specialists are shown in Table 5. Mortality was assessed at 30 days and 1 year for 5 of the studies and in-hospital for 4 others. There was a statistically significant variation across studies in 30-day mortality rates for patients treated by physicians in a given specialty. There was also a significant variation in the unadjusted odds ratios comparing generalists to cardiologists. For all studies the unadjusted mortality rates were lower for cardiologists than for other specialties. For comparisons of family physicians, internists or combinations of generalists to cardiologists unadjusted odds ratios for in-hospital or 30-day mortality ranged from 1.14 to 1.59 and unadjusted 1-year mortality rates ranged from 1.37 to 1.66. Because the generalists treated higher risk patients in all the studies, however, the odds ratios were reduced, sometimes to less than 1.00, after adjusting for risk factors.

We examined whether the quality of the risk-adjustment was associated with results. Studies were considered to have better risk-adjustment if the cardiologists and generalists had similar patients ie, the patients were similar age[6] or all patients were less than 65[9] or the study adjusted for a comprehensive set of risk factors including patient comorbidities and functional status.[5] These studies all had adjusted odds ratios near 1.00. The studies with the greatest differences between generalists and specialists in patient age[10,18] for subjects older than 65[9] or that did not adjust for comorbidities[22] found that generalists had higher mortality than cardiologists, ie, the odds ratios were significantly >1.

In Table 5 we did not include a study of patients who survived a myocardial infarction for at least 3 months.[24] In that study the mortality rate in the postmyocardial infarction period for patients managed by generalists alone was 19.1% compared with 11.8% for patients managed by cardiologists alone or with a generalist, OR = 1.75, $P < .001$. After reducing confounding by using propensity scores to select patients that were similar with respect to 36 variables representing clinical characteristics, hospital care, medications at discharge and hospital characteristics, the mortality rates were 18.3% for the generalists and 14.6% for the cardiologists, OR = 1.32, $P < .001$. Another finding in this study was that patients of cardiologists were much more likely than patients of generalists to have angiography (26.8% vs 16.7%), angioplasty (11.8% vs 6.9%), bypass graft surgery (11.9% vs 7.0%), cardiac rehabilitation (36.4% vs 29.0%), or exercise stress testing (61.4% vs 52.8%). As with the other studies, this study did not take into account the reasons why the patient did not receive care from a cardiologist.

Table 5. Mortality Rate Comparisons among Specialties

Study	30-day or In-hospital Rates			1 year		
	MR (%)	OR	OR_{adj}	MR (%)	OR	OR_{adj}
Chen et al						
Card*	16.1	1.00	1.00	26.8	1.00	1.00
Spec	20.2	1.32†	0.98	36.9	1.60†	1.05
IM	19.2	1.24†	0.99	33.6	1.38†	1.03
FP	19.7	1.28†	0.96	34.4	1.43†	1.01
GP	22.2	1.49†	1.06	37.0	1.60†	1.08
Frances et al[7]						
Card*		1.00	1.00		1.00	1.00
NC		1.30†	1.04†		1.37†	1.10†
NC (IV)			1.10			1.06
Norcini et al[18]‡						
Card*	8.5	1.00	1.00			
IM	11.9	1.45†	1.25†			
FP	10.8	1.30†	1.25†			
Frances et al[23]						
Card*	18.9	1.00	1.00	31.3	1.00	1.00
Spec	25.6	1.48†	1.25†	46.5	1.91†	1.20†
IM	21.0	1.14†	1.25†	43.0	1.66†	1.11†
FP	21.7	1.19†	1.11†	43.0	1.66†	1.30†
Nash et al[9]‡ age <65						
Card*	4.1	1.00	1.00			
Generalists	4.3	1.05	0.95			
Nash et al[9]‡ age >65 (in hospital rates)						
Card*	13.7	1.00	1.00			
Generalists	16.8	1.27	1.22			
Casale et al[10]‡						
Card*	8.5	1.00	1.00			
Gen	11.8	1.44†	1.20†			
Nash et al[13]‡			1.00			
Card*	7.9	1.00	1.26†			
IM	12.0	1.59	1.29†			
FP	11.1	1.44				
Ayanian et al[6]						
Card*	16.6	1.00	1.00	24.4	1.00	1.00
Gen	20.8	1.32†	1.06	29.5	1.30†	0.99
Jollis et al[22]						
Card*	15.7	1.00	1.00	27.3	1.00	1.00
IM	20.3	1.37†	NR	34.0	1.37†	1.14†
FP	20.4	1.38†	NR	34.7	1.42†	1.11†
GP	22.1	1.52†	NR	36.1	1.50†	1.20†
Uk	24.7	1.76†	NR	36.9	1.56†	1.32†

* Reference group. Odds ratios are 1.00 because cardiologists are the reference group.
† Significant at $P < .01$.
‡ Studies reported mortality rates in the hospital rather than 30 day. MR, mortality rate; OR, odds ratios of cardiologist compared with other specialties; OR_{adj}, adjusted odds ratio; Card, cardiologists; Spec, internal medicine subspecialist not in cardiology,; IM, general internist; FP, family physician; GP, general practice; N-C, non-cardiologists; NC (IV), noncardiologist adjusting for instrumental variable; NR, not reported; Uk, unknown.

Discussion

We systematically reviewed studies that compared cardiologist and generalists for outcomes of patients with myocardial infarction. The studies consistently found that patients of generalists were at greater risk of mortality from both cardiac and noncardiac risk factors and had higher unadjusted mortality rates. Studies varied as to whether or not generalists had higher mortality rates after adjusting for risk factors.

The generalists may have treated higher risk patients because patients who were too old or sick to want heroic intervention measures or revascularization procedures did not want to be referred to cardiologists. It is also possible that generalists' patients were at higher risk because they had greater delay in accessing care. It is unclear why adjusting for patient risk factors did not give consistent findings across studies. We hypothesized that the procedures used to take into account patient risk were not adequate and that the most valid results would be those that had the least differences between the patients of generalist and specialists or that did the best job of accounting for differences in patient risk. The best studies may have been the ones that had similar age patients for generalists and specialists,[6] that excluded older patients,[9] or that adjusted for the most complete set of risk factors.[5] All these found that cardiologists and generalists had similar adjusted mortality rates. On the other hand, the studies that had the greatest patient differences between specialties (as indicated by large differences in age or baseline 1-year mortality rates),[10,18,23] or that used fewer risk factors for adjustment[22] found the greatest differences between the cardiologists and generalists.

No analyses took into account the reason cardiologists were not consulted. These reasons may include patient location, socioeconomic factors,[25] severity of comorbidities, or patient-perceived health status. Results from a study that examined patient refusal of cardiac revascularization suggest that patient preference is also a reason.[26] That study found greater refusal among patients who were older, female, minorities, in smaller hospitals, or cared for by generalists.

Another contributor to differences between specialties is the method used to handle transfers. Transfers involved a high percentage of patients in most studies reviewed (see Table 1). It has been shown that transferred patients have a much lower in-hospital mortality rate than other patients (4.6% vs 11.4%).[27] For the studies reviewed, transferred patients were either eliminated[5,7,9,10,23] or assigned to a cardiologist[22] or shared care.[6] Both these methods of handling transfers assign lower risk patients to groups that involve care by a cardiologist. Primary care physicians will be left with high-risk patients who are not transferred. Including a variable for patient transfer in a regression equation will not be an adequate adjustment because generalist patients who are not transferred will be at higher risk than cardiologist patients who are not transferred. The best way of analyzing transferred patients is to associate their outcome to the physician who transferred them.

This review is not the first to suggest that patient and hospital factors may contribute to different outcomes for cardiologists and generalists.[5,7] However, this suggestion has not been proven or generally accepted,[28] and even the need for careful adjustment of confounding variables has not been universally recognized.[29]

Although this review did not resolve the appropriate role for generalists in managing patients with myocardial infarction, it does suggest what information should be collected for future studies. In particular, it would be helpful if generalists documented when care deviates from established standards by noting the contributions of patient preferences, environmental limitations, and unique patient circumstances. Studies could also improve their methods for accounting for patient risk (clinical, comorbid, and demographic), access of health care resources, and transfer to another facility. To the extent possible, study information should be collected by abstracters who do not know the purpose of the study or the specialty of the involved physicians.

The lower patient mortality rates following a myocardial infarction of cardiologists than generalist have led some authors to conclude that cardiologists know better than generalists how to manage myocardial infarction.[8,9] The self-evident correctness of the conclusion may have obscured the methodological deficiencies in the studies that support it. However, the conclusion results from a misunderstanding of the study design, which did not really evaluate the relative expertise of physician specialties. Because generalists can usually refer to a cardiologist, the studies actually evaluated

whether generalists made timely and appropriate referrals. If they did not, then perhaps patients who may be having a myocardial infarction should go directly to a cardiologist. Because taking responsibility for care from generalists is a major policy decision, it should only be made with substantial evidence. Evidence from the studies reviewed in this manuscript was questionable. In all the studies, generalists treated higher risk patients, and some of these patients may have had needs other than survival. To adequately assess the influence of physician specialty on patient outcome, studies should carefully consider patient needs, patient risk, and the realistic medical options available.

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