Treatment of Patients Admitted to the Hospital With Congestive Heart Failure: Specialty-Related Disparities in Practice Patterns and Outcomes

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Objectives. This study sought to define specialty-related differences in the care and outcome of patients admitted to the hospital with congestive heart failure (CHF).

Background. Congestive heart failure is the leading diagnosis-related group (DRG) discharge diagnosis in the United States and accounts for an estimated annual hospital cost in excess of $7 billion. The clinical impact of aggressive CHF management and the importance of the subspecialist in guiding this care have not been evaluated.

Methods. To define differences in physician practice patterns, we performed a chart review of consecutive patients admitted to a university teaching hospital with a primary DRG discharge diagnosis of CHF. We compared treatment and outcome of patients cared for by a generalist (n = 160) and those whose care was guided by a cardiologist (n = 138) during their index hospital period with CHF and over the next 6 months.

Results. At our institution, >50% of patients admitted to the hospital with CHF cared for by generalists alone had minimal (New York Heart Association functional class I or II) symptoms, compared with <15% of those cared for by a cardiologist (p < 0.01). Although generalists' patients underwent significantly fewer in-hospital diagnostic tests and had shorter lengths of stay, they had a 1.7-fold increased risk of readmission for CHF within 6 months (p < 0.05). Six-month cardiac and all-cause mortality were not significantly different between the groups. The type of physician caring for the patient and a history of diabetes, previous CHF or myocardial infarction were independent predictors of readmission for CHF.

Conclusions. Involvement of a cardiologist in the care of patients admitted to the hospital with CHF is associated with increased use of diagnostic testing, longer hospital stays and improved clinical outcome. These results substantiate practice guidelines that suggest a role for cardiologists in the care of symptomatic patients with CHF.

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Congestive heart failure (CHF) is a major public health problem that affects >2 million people and causes 200,000 deaths annually in the United States (1). Three-year mortality from CHF is related to severity of symptoms and ranges from 40% in patients in New York Heart Association functional class I to 82% in those in class IV (2). Currently, CHF is the leading diagnosis-related group (DRG) discharge diagnosis in the United States, accounting for nearly 1 million hospital admissions each year, at an estimated annual cost in excess of $7 billion (1). Therefore, CHF has become a target for cost reduction in regions with a high penetrance of managed care.

Recently, clinical practice guidelines have suggested that CHF should be aggressively managed in the outpatient setting and that hospital admission should be reserved for those with new-onset moderate to severe heart failure, recurrent CHF complicated by acutely threatening events or clinical situations or decompensated chronic CHF (3). These guidelines also suggest that thorough diagnostic evaluations should be performed in all patients with heart failure to identify etiologic factors, determine prognosis and guide therapy (1,3). Furthermore, the guidelines highlight the importance of therapeutic interventions that have been demonstrated to improve survival in patients with CHF.

The care of patients with heart failure is not exclusively within the purview of the cardiologist. Indeed, in both academic medical centers and community hospitals, the care of patients with CHF may be exclusively provided by primary care physicians, despite published guidelines suggesting a role for

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Abbreviations and Acronyms

ACE = angiotensin-converting enzyme
CHF = congestive heart failure
DRG = diagnosis-related group

the cardiologist (1). However, the value of the specialist in the care of the large population of patients with CHF has not been assessed. Therefore, we studied the clinical characteristics and courses of consecutive patients admitted to a university teaching hospital with a primary discharge diagnosis of CHF. To define differences in physician practice patterns, we compared treatment and outcome of patients admitted to the hospital with CHF treated by a generalist and those whose care was guided by a cardiologist.

Methods

Study group. We studied 328 consecutive patients discharged from the University of Pittsburgh Medical Center between January 1 and September 30, 1995, with a primary DRG discharge diagnosis of CHF. Thirty patients were excluded from the study because they previously had orthotopic heart transplants (n = 11) or were not treated by generalists or cardiologists (n = 19). The remaining 298 patients were divided into two groups: generalists' patients (n = 160) were exclusively cared for by a family practitioner or an internist; and cardiologists' patients (n = 138) were cared for by a full-time university cardiologist alone or in conjunction with a generalist.

Data collection. Hospital charts were abstracted by four cardiovascular research nurses who had no knowledge of the study design. Abstracted data included demographic information and medical history, including age, gender, race, site of initial presentation (physician's office, emergency department, transfer from another hospital, elective admission from home), comorbidities (e.g., coronary artery disease, hypertension, insulin-dependent or non–insulin-dependent diabetes) and history of previous CHF or a cardiovascular event. Severity of illness was characterized by recording the patient's functional class at the time of initial presentation. Surrogate markers of illness severity, including admission heart rate and serum blood urea nitrogen, creatinine and sodium levels, were also collected.

Clinical practice patterns were identified by collecting variables such as the prescribed level of hospital care at the time of admission (intensive care unit, cardiac intermediate care unit, general medical floor) and prehospital and in-hospital treatment with heart failure medications. The use of diagnostic modalities, including echocardiography, radionuclide ventriculography and right and left heart catheterization, were also recorded.

In-hospital outcomes included the length of hospital stay and the frequency of cardiac and overall death during the index admission. Follow-up outcomes included cardiac and overall mortality and CHF-related readmission (readmission to our institution for a primary DRG discharge diagnosis of CHF) over 6 months. The frequencies of cardiac death, defined as deaths primarily caused by either CHF, primary cardiac arrest or myocardial infarction, and all-cause death during the 6-month study period were determined by comparing a list of study patients with death certificates issued by the Commonwealth of Pennsylvania. (These data were supplied by the Division of Health Statistics and Research, Pennsylvania Department of Health, Harrisburg, Pennsylvania, who specifically disclaims responsibility for any analyses, interpretations or conclusions of this study.)

Statistical analysis. Continuous data are expressed as mean value ± SD. Medians and ranges are also reported for continuous outcome data. Because the continuous variables were, in general, not normally distributed, comparisons between groups were performed using the nonparametric Wilcoxon rank-sum test. Categoric data were compared between the two groups using chi-square analysis. Such comparisons with fewer than five expected cases in a cell were performed using the Fisher exact test. For all comparisons, $p \leq 0.05$ was considered significant.

Forward stepwise regression modeling (entering terms with $p < 0.10$) was used to determine whether treatment group was independently associated with in-hospital and follow-up outcomes. Baseline patient characteristics considered in these models were gender, age ≥ 65 years, race, diabetes, hypertension, functional class, history of CHF and history of myocardial infarction. Logistic regression was used for modeling binary in-hospital outcomes, whereas linear regression on the logarithmic scale was used for length of hospital stay.

Life-table analysis (4) was used to calculate 6-month event rates for cardiac death and readmission for CHF. Patients who died without an event were censored at the time of death, whereas patients known to have survived 6 months without an event were censored at the 6-month time point. Freedom from event curves were compared using the log-rank test (5). Cox regression analysis (6) was used for multivariate modeling of the time-until-event data.

Results

Subject demographics. The clinical characteristics of the two groups are summarized in Table 1. Generalists cared for older patients (mean age 72.6 vs. 68.9 years, p < 0.01) and a higher proportion of women (67.5% vs. 47.8%, p < 0.01). Generalists' patients were hospitalized with less severe CHF, as manifested by a lower likelihood of functional class III or IV CHF symptoms on admission (47.2% vs. 85.6%, p < 0.01) (Fig. 1) and significantly lower serum blood urea nitrogen and creatinine, although serum sodium level and rest heart rate did not differ between the groups. Cardiologists cared for higher proportions of patients with CHF and a history of coronary artery disease or myocardial infarction, although the prevalences of other comorbidities, including previous diagnoses of

Table 1. Characteristics of Patients Admitted to the Hospital With Congestive Heart Failure and Treated by a Generalist Alone or by a Generalist in Consultation With a Cardiologist or a Cardiologist Alone

	Patients Treated by Generalists (n = 160)	Patients Treated by Cardiologists (n = 138)
Demographics		
Age (yr)*	72.6 ± 15.0	68.9 ± 12.7
Female gender*	67.5	47.8
White	66.9	76.1
African-American	33.1	23.9
Past medical history		
Coronary artery disease†	44.4	58.7
Congestive heart failure	69.4	71.7
Hypertension	51.9	52.2
Diabetes requiring Rx	35.0	38.4
Myocardial infarction*	26.9	45.7
Clinical characteristics		
NYHA functional class*		
I	19.5	4.4
II	33.3	10.1
III	30.2	34.1
IV	17.0	51.5
BUN (mg/dl)*	26.5 ± 18.5	33.4 ± 22.6
Creatinine (mg/dl)*	1.6 ± 1.8	1.8 ± 1.5
Serum sodium (mg/dl)	137.5 ± 4.1	137.1 ± 5.7
Heart rate (beats/min)	95.8 ± 31.7	95.1 ± 24.2

*p < 0.01 and †p < 0.05 for comparison of distributions in groups. Continuous data are expressed as mean value ± SD and analyzed using the nonparametric Wilcoxon rank-sum test; categoric data are presented as percentage of patients with the characteristic and analyzed by chi-square analysis. BUN = blood urea nitrogen; NYHA = New York Heart Association; Rx = drug prescription.

CHF, hypertension and diabetes, were not significantly different between the groups.

Physician practices. There was a significant discrepancy between the groups in the prescribed level of hospital care and use of diagnostic testing, despite similar locations of presentation. Although the majority of the generalists' patients were admitted to a general medical floor, significantly fewer of those cared for by cardiologists were assigned to this level of care (58.1% vs. 23.9%, p < 0.01); most cardiologists' patients were admitted to intensive or cardiac intermediate care units. During the index hospital period, generalists ordered fewer noninvasive and invasive cardiac diagnostic tests to guide their care plan. Specifically, lower proportions of generalists' than cardiologists' patients underwent inpatient echocardiography (34.4% vs. 49.3%, p < 0.01), radionuclide ventriculography (1.3% vs. 7.2%, p = 0.02) and right heart catheterization (0% vs. 2.9%, p = 0.046). No patients in either group underwent left heart catheterization during the index hospital period.

The prehospital heart failure medication profiles in the two groups are notable for a lower prevalence of angiotensin-converting enzyme (ACE) inhibitor use among generalists' patients (30.0% vs. 44.2%, p = 0.01), although a minority of patients in both groups were being treated with these agents
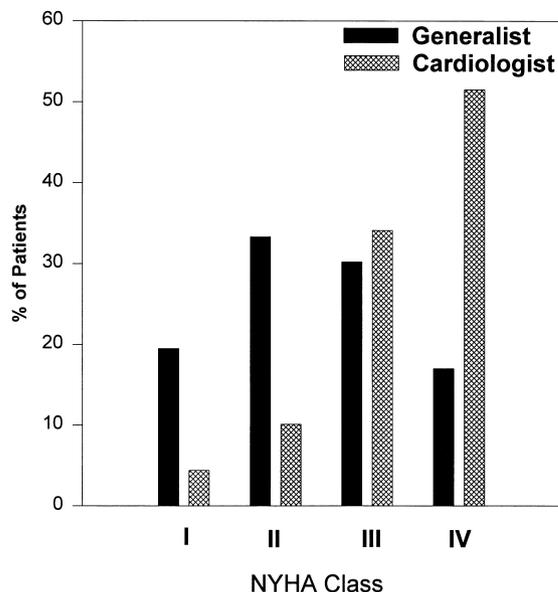

Figure 1. Severity of presenting CHF symptoms during the index hospital period, according to New York Heart Association (NYHA) functional class. p < 0.01, generalist versus cardiologist.

(Table 2). The proportions of those using digoxin, diuretics and nitrates before hospital admission did not differ between the groups. During their hospital stay, patients treated by cardiologists had 9.5-fold and 3.4-fold higher likelihoods of being treated with intravenous inotropes (p < 0.01) and dopamine, respectively (p = 0.07). No patient received other vasopressors or intravenous vasodilators. The likelihood of

Table 2. Prehospital, In-Hospital and Discharge Medications of Patients Admitted to the Hospital With Congestive Heart Failure and Treated by a Generalist Alone or by a Generalist in Consultation With a Cardiologist or a Cardiologist Alone

	Patients Treated by Generalists (n = 160)	Patients Treated by Cardiologists (n = 138)
Prehospital		
ACE*	30.0	44.2
Digoxin	37.5	47.8
Diuretic	68.1	69.6
Nitrates	32.5	39.1
In-hospital		
IV diuretic therapy	88.1	90.6
IV inotropic therapy†	1.3	12.3
IV vasopressor therapy*	1.9	6.5
Discharge‡		
ACE	46.1	57.1
Digoxin	46.1	53.2
Diuretic*	76.6	87.3
Nitrates†	37.0	52.4

*p < 0.05 and †p < 0.01 for comparison of distributions in groups. Data are expressed as percent of patients with the characteristic. ‡Discharge medication data reflect incomplete follow-up in generalist-treated (n = 154) and cardiologist-treated patients (n = 126). ACE = angiotensin-converting enzyme; IV = intravenous.

Table 3. Outcomes of Patients Admitted to the Hospital With Congestive Heart Failure and Treated by a Generalist Alone or by a Generalist in Consultation With a Cardiologist or a Cardiologist Alone

	Patients Treated by Generalists (n = 160)	Patients Treated by Cardiologists (n = 138)
In-hospital		
Length of stay (days)*		
Mean ± SD	6.0 ± 5.3	6.9 ± 4.7
Median	4	5
Range	1–34	1–25
All-cause mortality	3.1%	8.0%
Cardiac mortality	2.5%	6.5%
Six-month follow-up‡		
All-cause mortality	23.8%	21.7%
Cardiac mortality	14.6%	14.1%
≥1 readmission for CHF†	44.3%	30.7%

*$p < 0.01$ and †$p < 0.05$ for comparison between groups. ‡Six-month event rates are calculated using the life-table technique and compared between groups with the log-rank test. CHF = congestive heart failure.

receiving intravenous diuretic agents during the hospital period did not differ. At discharge, there were no statistically significant differences in the prescription of an ACE inhibitor or digoxin, but generalists' patients were less likely to be discharged with prescriptions for oral diuretic agents (76.6% vs. 87.3%, $p = 0.02$) or nitrates (37.0% vs. 52.4%, $p = 0.01$). The differences in medication use during the hospital period and prescription at discharge remained significant when adjustment was made for patient baseline characteristics (not shown).

Clinical outcomes. In addition to having less severe CHF on admission, patients whose hospital care was guided by a generalist alone had a significantly shorter duration of hospital stay (6.0 vs. 6.9 days, $p < 0.01$) (Table 3). Although in-hospital cardiac mortality was somewhat higher among patients cared for by cardiologists, rates were not significantly different between the groups, both univariately and after adjustment for baseline patient factors. In-hospital all-cause mortality was likewise not significantly different between the groups.

Life-table analysis showed that 6-month cardiac mortality did not differ between the groups (14.6% for patients cared for by generalists vs. 14.1% by cardiologists, $p = NS$). However, examination of survival curves (Fig. 2A) showed higher follow-up cardiac mortality among patients cared for by generalists, in contrast to their somewhat lower in-hospital cardiac death rates. All-cause mortality at 6 months did not differ between the groups. A similar analysis of cardiac readmission (Fig. 2B) demonstrated that patients with CHF treated by generalists alone during their index hospital period were more likely to be readmitted with a primary DRG diagnosis of CHF over the subsequent 6 months (44.3% vs. 30.7%, $p = 0.048$ by log-rank test).

Cox regression analysis found that the type of physician guiding hospital care during the index admission for CHF is a strong independent predictor of readmission (Table 4). Spe-
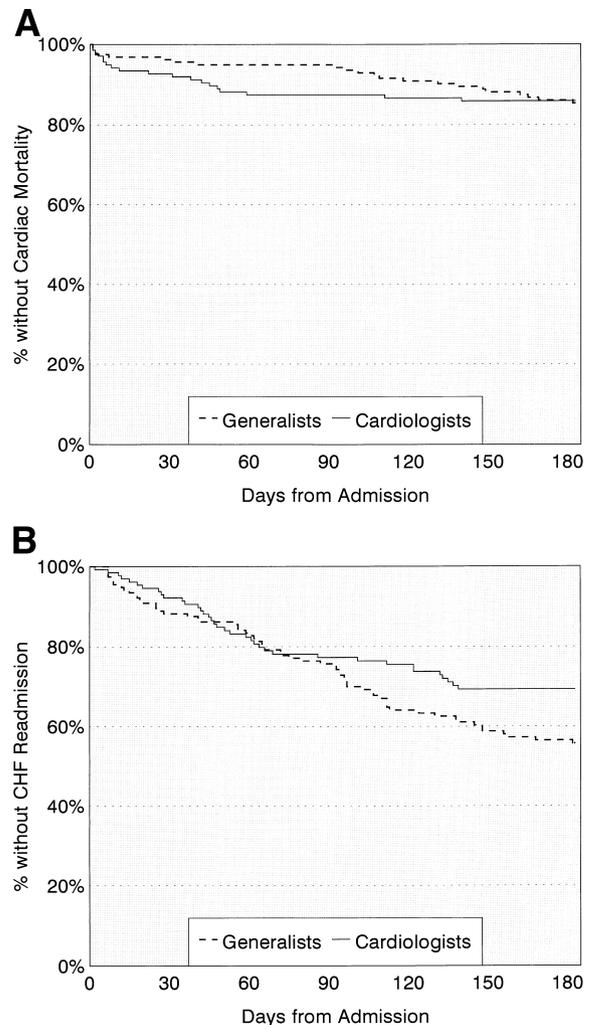

Figure 2. Survival curves for 6-month follow-up cardiac mortality (**A**) and readmission for CHF (**B**) in patients treated by a generalist alone or by a generalist in consultation with a cardiologist or a cardiologist alone. (The 6-month readmission rate for CHF was significantly different between the groups [$p = 0.048$ by log-rank test].)

cifically, when adjustment was made for patient characteristics associated with readmission, generalists' patients had a 1.7 times increased risk of being readmitted with CHF within 6 months. After adjustment, other independent predictors of readmission for CHF were a history of diabetes requiring oral hypoglycemic or insulin therapy and previous CHF or myocardial infarction. Gender, age, functional class, race and previous history of coronary artery disease or hypertension did not independently influence readmission.

Discussion

The results of this study suggest that there are specialty-related disparities in clinical practice patterns in patients admitted to our institution with CHF. Those patients under the care of a cardiologist had more severe heart failure symptoms but a lower 6-month readmission rate for CHF when compared

Table 4. Patient Characteristics Showing Univariate and Independent Association With Readmission for Congestive Heart Failure Within 6 Months by Cox Regression

	Univariate		Multivariate	
	RR	95% CI	RR	95% CI
Treatment by generalist (vs. cardiologist)	1.50*	1.00–2.25	1.69*	1.11–2.56
History of diabetes	1.57*	1.06–2.32	1.54*	1.04–2.28
History of CHF	1.95*	1.20–3.15	1.78*	1.10–2.90
History of MI	1.53*	1.03–2.28	1.57*	1.05–2.37
History of CAD	1.45†	0.97–2.15	(not entered)	

*$p < 0.05$ and †$p < 0.10$ for significance of test that relative risk (RR) is different from 1. CAD = coronary artery disease; CHF = congestive heart failure; CI = confidence interval; MI = myocardial infarction.

with patients whose care was directed by a generalist. Despite having more severe CHF and a higher prevalence of coronary disease, patients cared for by a cardiologist had similar in-hospital and 6-month cardiac and all-cause mortality rates. However, during the index hospital period, cardiologists' patients had significantly longer hospital stays, underwent more inpatient diagnostic cardiac tests and were more frequently treated with in-hospital intravenous inotropes. The specialty-related disparities in practice patterns demonstrated in this study parallel those reported by investigators studying other cardiac syndromes such as myocardial infarction and unstable angina (7,8).

Explanations of findings. The present study was not designed to identify the causes for the paradoxic findings that patients with CHF treated by cardiologists had a lower 6-month readmission rate for CHF and similar cardiac and overall mortality rates despite having more severe CHF symptoms during their index hospital stay. These compelling findings were unexpected because previous studies have demonstrated a close association between CHF symptom severity and survival (2). However, we can speculate that this disparity might be due to the beneficial effects of aggressive inpatient management of cardiologists' patients with intravenous inotropic therapy. Alternatively, the more frequent use of noninvasive and invasive assessments of cardiac function may have allowed cardiologists to better define the pathophysiologic mechanism of heart failure as being either systolic or diastolic dysfunction, thereby enabling them to tailor in-hospital and posthospital therapy and limit rehospitalization for CHF (9).

The finding that generalists' patients had less severe heart failure symptoms suggest that they may have been more likely to have had diastolic dysfunction as the cause of their CHF. However, we were unable to determine the prevalence of diastolic dysfunction in the study group because of the infrequent clinical use of echocardiography and radionuclide ventriculography. Because mortality from diastolic dysfunction is less than that from systolic dysfunction, an increased prevalence of diastolic dysfunction as the cause for minimal CHF symptoms in the generalists' patients would be expected to be associated with a lower mortality rate. Alternatively, cardiologists may have cared for more patients presenting with acute pulmonary edema, which is associated with high cardiac mor-

tality. However, cardiac mortality rates were similar between the groups.

Although the majority of cardiologists' patients were cared for by general cardiologists, the availability of a focused and integrated outpatient heart failure clinic within the cardiology group at our institution might have also provided long-term benefits. Finally, we cannot exclude the possibility that cardiologists have greater knowledge of outpatient modalities associated with decreased CHF morbidity and mortality. Although generalists and cardiologists discharged similar proportions of patients receiving an ACE inhibitor and digoxin, the finding that a significantly greater proportion of patients cared for by cardiologists were receiving an ACE inhibitor at the time of admission suggests that there may be specialty-related discrepancies in outpatient management of CHF. Such discrepancies would be expected to influence long-term outcome, including rehospitalization for CHF and cardiac death.

Study limitations. The present study is limited by several facts: 1) it was a nonrandomized study, resulting in patient groups that were not matched for baseline covariates; 2) patients were identified by their primary DRG discharge diagnosis rather than admission diagnosis; 3) death certificates were used to differentiate between cardiac and noncardiac death; and 4) readmission was only assessed at our institution. However, randomization would have been impossible, as it would have revealed the study purpose to both the patient and the caregiver, thereby potentially causing patient refusal and treatment bias. Furthermore, although hospital coders may have shifted patients discharged with a poorly reimbursed non-CHF primary diagnosis to the more lucrative CHF DRG, this would presumably have biased the study toward a lower CHF readmission rate in the cohort with less symptomatic patients. In contrast, our data demonstrated a higher readmission rate among generalists' patients, who had less severe symptoms.

We used death certificates obtained from the Commonwealth of Pennsylvania because it enabled us to assess the vital status of all patients, unless they moved or died out of state. In addition, assignments of cause of death on the certificates were made by primary clinicians who were unaware of the study end points; therefore, bias was not an issue. However, although death certificates provide an accurate overall mortality rate, we

may have underestimated the 6-month cardiac death rate, because objective evidence of cause of death may not be readily available to clinicians completing death certificates for patients who died outside a hospital environment. Finally, although readmission for CHF was only assessed at our institution, most generalists' patients use our institution as their primary care facility and most of those cared for by our full time cardiologists either present initially to our institution or are immediately transferred to our hospital. Therefore, it is likely that we captured most readmission data. In addition, this potential limitation does not explain the finding that both groups had similar cardiac mortality confirmed by the Commonwealth of Pennsylvania's Division of Health Statistics.

Although the present study identified specialty-related differences in clinical characteristics, evaluation, treatment and outcomes of patients with CHF at our university teaching hospital, it is not clear whether our results may be generalized to patients with CHF admitted to nontertiary care hospitals. However, our patients' characteristics are not entirely consistent with those of patients with CHF treated in tertiary care hospitals. For instance, the proportions of our patients treated with an ACE inhibitor before admission and at discharge were lower than those of patients participating in large-scale CHF clinical trials of nonvasodilator pharmacologic therapy performed at tertiary care hospitals (10). In addition, our finding that the majority of generalists' patients were admitted in functional class I or II CHF is also not consistent with expected practice patterns in a tertiary care institution. These observations suggest that our study group may be representative of patients admitted to the hospital with CHF in the United States.

Conclusions. Despite the obvious limitations of a chart review in assessing physician practices, this study demonstrates that, as compared with cardiologists, generalists in our institution: 1) care for patients admitted to the hospital with CHF who are significantly less symptomatic; and 2) are less likely to guide hospital care for patients with CHF with diagnostic cardiac tests. Although we cannot directly relate these differences in practice patterns to differing outcomes, it is notable

that the patients treated by cardiologists had a 6-month cardiac mortality equal to that of the patients cared for by generalists, despite having more severe disease and a higher prevalence of coronary disease. Thus, our results substantiate practice guidelines that suggest a role for cardiologists in the care of symptomatic patients with CHF. However, our results also suggest that CHF treatment guidelines need to be more uniformly applied by all physicians caring for patients with heart failure. Further study will be required to assess disparities in the care of patients presenting with their first episode of heart failure and those receiving outpatient therapy.

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