

# Care and Outcomes of Patients Newly Hospitalized for Heart Failure in the Community Treated by Cardiologists Compared With Other Specialists

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**Background**—It is not known whether subspecialty care by cardiologists improves outcomes in heart failure patients from the community over care by other physicians.

**Methods and Results**—Using administrative data, we monitored 38 702 consecutive patients with first-time hospitalization for heart failure in Ontario, Canada, between April 1994 and March 1996 and examined differences in processes of care and clinical outcomes between patients attended by physicians of different disciplines. We found that patients attended by cardiologists had lower 1-year risk-adjusted mortality than those attended by general internists, family practitioners, and other physicians (28.5% versus 31.7%, 34.9%, and 35.9%, respectively; all pairwise comparisons,  $P<0.001$ ). The 1-year risk-adjusted composite outcome of death and readmission for heart failure was also lower for the cardiologists compared with family practitioners and other physicians but not general internists (54.7% versus 58.1%, 58.3%, and 55.4%;  $P<0.001$ ,  $P<0.001$ , and  $P=0.39$ , respectively). Multivariable hierarchical modeling demonstrated a significant physician-level effect for both outcomes in favor of the cardiologists, particularly against non-general internists. Cardiologist care was associated with higher adjusted rates of invasive interventions and postdischarge prescriptions of heart failure medications.

**Conclusions**—In this population-based cohort, heart failure patients attended by cardiologists in hospital had lower risk of death as well as the composite risk of death or readmission than patients attended by noncardiologists. These data raise the need to identify specialty-driven differences in processes of care for heart failure patients, which may explain the observed disparity in clinical outcomes that presently favor cardiologist care. (*Circulation*. 2003;108:184-191.)

**Key Words:** heart failure ■ prognosis ■ population ■ mortality ■ morbidity

Despite the dissemination of clinical guidelines<sup>1,2</sup> on the treatment of heart failure, wide variations still exist in practice patterns between physicians of differing specialties who care for patients with this condition.<sup>3</sup> Past observational studies have suggested that patients who were hospitalized for heart failure might receive better evidence-based care if attended by cardiologists compared with physicians of other disciplines.<sup>4,5</sup> It remains unclear, however, whether these differences would result in improved clinical outcomes that would favor cardiologist-delivered care.<sup>4,6</sup> Furthermore, if such specialty-related disparity in either care or outcome exists, it will be most visible among patients who are hospitalized for the initial heart failure episode, during which subspecialty care is expected to make the greatest impact.<sup>7</sup> In this study, we conducted a population-based analysis to determine physician specialty-related differences in the care and outcome of unselected patients who were admitted for an

initial episode of heart failure in Ontario, Canada, a province with a population of 11 million people. We hypothesized that differences would exist in selected processes of care of patients hospitalized for heart failure between physicians of differing specialties and that specialty care by cardiologists delivered in hospital would be associated with improved outcomes compared with care delivered by general internists, family practitioners, and physicians of other disciplines.

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## Methods

### Cohort Construction

Using data from the Canadian Institute for Health Information (CIHI),<sup>8</sup> we constructed a cohort of consecutive patients who were hospitalized for the first time for heart failure in Ontario between April 1, 1994 and March 31, 1996.<sup>9</sup> We identified all individuals

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( $n=75\,642$ ) who were admitted with a primary diagnosis of congestive heart failure (*International Classification of Diseases*, 9th Revision, code 428). We excluded individuals who were younger than 20 years of age ( $n=273$ ), those without a valid Ontario health card number ( $n=927$ ), those admitted to chronic care facilities ( $n=713$ ), those transferred from another acute care facility ( $n=1626$ ), and non-Ontario residents ( $n=660$ ). We also excluded cases where heart failure was coded as a hospital complication ( $n=493$ ) and all cases in which it was not the first admission for heart failure in the time period of the study ( $n=23\,268$ ). Finally, we excluded all patients who had a diagnosis of heart failure coded during any hospital admission in the 5 years before this study ( $n=8980$ ).

### Indicators and Outcomes

We classified all admissions according to the medical specialty of the most responsible physician noted on the discharge records—cardiologist, general internist, family practitioner, or physician of other disciplines. The most responsible physician was defined as the single physician who provided the most days of in-hospital care. When the duration of care provided was equal among 2 or more physicians, the most responsible physician was the one who last cared for the patient. Physician specialties were assigned by the hospitals and reflected both the level of training and the type of services provided by the physicians.

Comorbidities were abstracted from the discharge abstracts of all hospitalizations within 5 years before the index admission using the Deyo adaptation<sup>10</sup> of the Charlson comorbidity index.<sup>11</sup> We captured the use of cardiac catheterization, percutaneous coronary interventions, and coronary artery bypass graft surgery within 30 days of index admission by linking our CIHI data to the Ontario Health Insurance Plan and the Ontario Same Day Surgery databases using encrypted health card numbers. We chose a 30-day cutoff to accommodate waiting times for these procedures. We also linked to the Ontario Drug Benefit database<sup>12</sup> to capture the 90-day preadmission and 30-day postdischarge cardiac drug use for patients aged  $\geq 65$  years. Readmissions attributable to heart failure after the index event were identified from the CIHI database. Deaths were captured by searching through both CIHI and the Ontario Registered Persons Database of Vital Status.

### Quality of Administrative Databases

Fourteen acute care hospitals in Ontario with a minimum volume of 100 heart failure admissions per year participated in chart audits to validate the accuracy of our administrative databases for patients with heart failure. Trained abstractors, who were blinded to the original data, reviewed randomly selected charts of patients with first-time hospitalization for heart failure between April 1, 1997, and March 31, 1999. We applied the Framingham criteria<sup>13</sup> and the Carlson heart failure score<sup>14</sup> to ascertain the diagnosis of heart failure on admission. The diagnosis of heart failure was confirmed if 2 major or 1 major and 2 minor Framingham criteria were concurrently present or alternatively if the Carlson heart failure score exceeded 4 points. We also recorded the medical specialty of the discharging physician. The reabstracted patient and physician data were then compared with our original data to determine the reliability of our databases.

### Statistical Analysis

Risk-adjusted outcome rates for mortality, readmission, procedure use, and postdischarge medication use were computed for patients treated by each physician specialty category. This was done by fitting multivariable regression models to adjust for patient-level characteristics that might confound our comparisons. Logistic regression was used to model 1-year mortality, the composite outcome of death or readmission at 1 year, procedure use, and postdischarge medication use. Poisson regression was used to model the number of readmissions within 1 year of discharge among survivors of the index admission. Only comorbidities with a prevalence of at least 1% in our cohort were considered for inclusion in our models.<sup>9</sup> All covariates that had a significance level of  $P<0.20$  by univariate

analysis were then entered into the multivariable models. Backwards elimination was used to select variables until all remaining covariates were significant at the  $\alpha=0.05$  level. The variables used in our case-mix adjustments included age, sex, history of myocardial infarction, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, rheumatologic disease, peptic ulcer disease, liver disease, diabetes, hemiplegia or paraplegia, renal disease, malignancy, and AIDS. The statistical significance of differences in adjusted rates was determined using permutation tests.<sup>15</sup> The  $c$  statistics<sup>16</sup> in our logistic models showed adequate discriminative powers (0.68 to 0.79), and Hosmer-Lemeshow  $\chi^2$  tests<sup>17</sup> showed no lack of fit ( $P=0.27$  to 0.94).

Risk-adjusted survival curves were computed using the corrected group prognosis method.<sup>18</sup> Log likelihood tests, based on the Cox proportional hazards models from which the curves were derived, were used to test for the overall significance of a physician specialty effect on clinical outcomes. Model selections for our Cox regression were done using the same method as described above.

Our data had a natural hierarchical structure, with patients treated by physicians, who in turn practice within hospitals.<sup>19</sup> To account for variables being measured at different levels of the hierarchy, multi-level logistic regression models were used to determine the relative odds for adverse outcomes between different physician specialties. The variables used for patient-level characteristics were identical to those used in the nonhierarchical models as described above. Physician specialty was used as the variable for physician-level characteristic, whereas hospital type/size was used as the variable for hospital-level characteristic. The hospitals were classified into the following types/sizes: teaching, large volume ( $\geq 100$  heart failure admissions per year), medium volume (33 to 99 admissions per year), and low volume ( $<33$  admissions per year). Such hierarchical modeling avoids the underestimation of the standard errors of the physician-level effect that are associated with traditional regression modeling.<sup>20</sup> The models yielded odds ratios (ORs) that described the adjusted risks in adverse outcomes comparing care by other physician specialties against care by cardiologists. Multilevel analyses were implemented using HLM version 5.<sup>21</sup> The remaining analyses were conducted using SAS 8.2 (SAS Institute Inc). The study was approved by the Research Ethics Board at the Sunnybrook & Women's College Health Sciences Centre.

## Results

### Cohort Characteristics

A total of 38 702 patients were hospitalized for heart failure for the first time during the study period. Of these, 14.2% were cared for by cardiologists, 35.0% by general internists, 41.0% by family practitioners, and 9.9% by other physicians (Table 1). Patients of cardiologists were younger and more likely to be male than patients of noncardiologists. Patients of cardiologists were more likely to have had a history of ischemic heart disease, atrial fibrillation, and prior cardiac surgery. Patients of cardiologists also had lower Charlson comorbidity scores than patients of noncardiologists. There was a higher preadmission use of cardiac medications for non-heart failure indications in the cardiologist group. Proportionally more cardiologist-managed patients were admitted to teaching hospitals, whereas more patients of noncardiologists were managed in community hospitals.

### Processes of Care

Table 2 shows that cardiologist care was associated with higher rates of invasive interventions than noncardiologist care. Patients attended by cardiologists had the highest adjusted rate of cardiac catheterization at 30 days compared with general internists, other physicians, and family practitioners (6.3% versus 2.7%, 1.8%, and 1.2%, respectively; all

**TABLE 1. Comparison of Admission Characteristics Between Heart Failure Patients Attended by Different Physician Specialties**

Characteristic	Cardiologists (n=5477)	General Internists (n=13 545)	Family Practitioners (n=15 861)	Other Physicians (n=3819)	P
Age, y	71.8	74.7	77.5	75.3	<0.001
Female gender, %	43.9	49.8	54.6	51.1	<0.001
Past cardiac history					
Ischemic heart disease, %	32.5	27.4	29.7	25.1	<0.001
Atrial fibrillation, %	10.5	8.5	9.4	8.8	<0.001
Prior cardiac surgery, %	3.5	1.6	1.4	1.5	<0.001
Comorbidities					
Chronic pulmonary disease, %	12.5	17.7	22.5	19.1	<0.001
Diabetes with chronic complications, %	2.5	1.7	1.3	2.5	<0.001
Renal dysfunction, %	4.6	7.2	5.4	10.7	<0.001
Charlson score	1.02	1.11	1.09	1.29	<0.001
90-Day preadmission medication use					
ACE inhibitors, %	42.8	37.1	36.1	33.3	<0.001
$\beta$ -Blockers, %	24.9	19.1	15.8	16.4	<0.001
Aspirin,* %	34.3	28.3	26.8	27.1	<0.001
Coumadin, %	17.8	12.1	10.7	10.9	<0.001
Hospital type/size†					<0.001
Teaching, %	39.4	24.5	3.8	38.4	
Large volume, %	50.3	54.9	32.9	50.7	
Medium volume, %	9.0	18.2	39.1	8.5	
Small volume, %	1.4	2.4	24.2	2.4	

\*Did not include over-the-counter use.

†Sized according to No. of heart failure admissions per year; large volume= $\geq 100$ , medium volume=33 to 99, low volume= $<33$ .

pairwise comparisons;  $P<0.001$ ). Similar differences in favor of cardiologists were also noted in the adjusted rates for percutaneous coronary interventions (0.2% versus 0.1%, 0.1%, and 0.06%;  $P=0.01$ , 0.05, and 0.01, respectively). At 30 days, more patients cared for by cardiologists underwent bypass surgery than other physicians and family practitioners but not general internists (adjusted rates, 0.9% versus 0.5%, 0.3%, and 0.7%;  $P=0.02$ ,  $P\leq 0.001$ , and  $P=0.24$ ).

Among hospital survivors, significant between-specialty differences were seen in the 30-day postdischarge adjusted rates of heart failure medication use (Table 2). ACE inhibitor use was higher among the cardiologists than family practitioners or other physicians but not general internists (adjusted rates, 63.8% versus 58.1%, 56.3%, and 63.9%;  $P<0.001$ ,  $P<0.001$ , and  $P=0.87$ ).  $\beta$ -Blocker use was highest among the cardiologists, followed by general internists, other physicians, and family practitioners (adjusted rates, 15.1% versus 11.0%, 8.7%, and 7.2%; all  $P<0.001$ ).

### Clinical Outcomes

The Figure and Table 3 showed that the risk-adjusted outcomes were highly disparate between patients cared for by different physician groups. The lowest in-hospital mortality rate was observed with the cardiologists, followed by general internists, family practitioners, and other physicians (risk-adjusted rates, 6.5% versus 8.9%, 10.4%, and 10.5%; all  $P<0.001$ ). This specialty-related gradient in mortality was apparent within the first 72 hours after admission (1.7%

versus 3.3%, 3.7%, and 3.8%; all  $P<0.001$ ). The mortality benefit associated with cardiologist care was sustained at 1 year (28.5% versus 31.7%, 34.9%, and 35.9%; all  $P<0.001$ ). The risk-adjusted number of heart failure readmissions per patient year among survivors of the index admission was similar between the physician groups at 1 month. At 1 year, the rate was slightly higher with the cardiologists than general internists and other physicians but not family practitioners (risk-adjusted number per patient-year, 0.76 versus 0.70, 0.70, and 0.73;  $P=0.004$ , 0.02, and 0.07). The composite outcome of death or readmission for heart failure at 1 month was lower among patients attended by cardiologists than general internists, family practitioners, and other physicians (risk-adjusted rates, 19.3% versus 21.9%, 23.2%, and 22.2%; all  $P<0.001$ ), although by 1 year the advantage over the general internists had been lost.

Table 4 showed that the mortality benefit associated with cardiologist care extended from the medium- to high-risk heart failure patients as predefined by age and the Charlson comorbidity score. In contrast, when only low-risk heart failure patients were considered, the 1-year mortality was similar between the physician groups.

Table 5 summarized the physician-level effect observed on death and readmission as derived from the hierarchical models. Compared with cardiologists, the risk of in-hospital death increased in succession from general internists to other physicians to family practitioners (respective OR, 1.44, 1.78, and 1.80 versus cardiologists; all  $P<0.001$ ). At 1 year,

**TABLE 2. Comparison of Selected In-Hospital and Postdischarge Processes of Care Between Physician Specialties\***

Process of Care	Cardiologists	General Internists	Family Practitioners	Other Physicians
30-Day procedure use				
Cardiac catheterization, %	8.0 (6.3)	2.8 (2.7)	1.0 (1.2)	1.8 (1.8)
		$P<0.001$	$P<0.001$	$P<0.001$
Percutaneous coronary interventions, %	0.3 (0.2)	0.1 (0.1)	0.05 (0.06)	0.1 (0.1)
		$P=0.01$	$P=0.01$	$P=0.049$
Coronary artery bypass surgery, %	1.1 (0.9)	0.8 (0.7)	0.2 (0.3)	0.5 (0.5)
		$P=0.24$	$P<0.001$	$P=0.02$
30-Day postdischarge medication use†				
ACE inhibitors, %	64.2 (63.8)	64.0 (63.9)	57.9 (58.1)	56.3 (56.3)
		$P=0.87$	$P<0.001$	$P<0.001$
$\beta$ -Blockers, %	15.5 (15.1)	11.1 (11.0)	7.1 (7.2)	8.7 (8.7)
		$P<0.001$	$P<0.001$	$P<0.001$
Digitalis, %	48.4 (48.8)	44.8 (44.9)	42.2 (42.1)	40.5 (40.5)
		$P<0.001$	$P<0.001$	$P<0.001$
Furosemide, %	80.1 (80.3)	80.8 (80.9)	76.4 (76.3)	76.3 (76.2)
		$P=0.51$	$P<0.001$	$P<0.001$
Aspirin,‡ %	31.4 (31.2)	27.5 (27.5)	19.5 (19.6)	23.5 (23.5)
		$P<0.001$	$P<0.001$	$P<0.001$
Coumadin, %	22.8 (22.1)	17.0 (16.8)	11.6 (11.8)	15.1 (15.1)
		$P<0.001$	$P<0.001$	$P<0.001$

\*Adjusted rates are enclosed in parentheses.  $P$  values are given for pairwise comparisons of adjusted rates against cardiologists.

†Restricted to patients aged  $\geq 65$  years for drugs prescribed under the Ontario Drug Benefit Program.

‡Did not include over-the-counter use.

survival remained favorable for the cardiologists compared with other specialty groups (ORs, 1.16, 1.40, and 1.44;  $P=0.002$ ,  $P<0.001$ , and  $P<0.001$ ). When the composite outcome of death and readmission was considered, cardiologist care had a significantly lower 1-month risk than care by general internists, family practitioners, and other physicians (OR, 1.14, 1.16, and 1.21;  $P=0.02$ , 0.009, and 0.001). At 1 year, the risk reduction seen with the cardiologists was lost against the general internists but remained sustained compared with family practitioners and other physicians (OR, 1.04, 1.16, and 1.14;  $P=0.32$ , 0.001, and 0.01).

Of the patients primarily attended by general internists and family practitioners, only 5.5% and 6.1%, respectively, received additional consultations from cardiologists. When these cases with cooperative care were excluded, the results did not differ significantly from our original analyses.

### Reliability of Administrative Data

Our administrative data were verified to be reliable by chart audits. Of the 1346 heart failure hospitalizations identified by CIHI, 1292 (96%) met the Framingham criteria and 1211 (90%) met the Carlson criteria for heart failure by chart abstraction. Among the 224 cases in which a cardiologist was identified by CIHI to be the most responsible physician, chart abstraction found matching specialty of the discharging physician in 208 cases (93%). On the other hand, among the 857 cases in which the discharging physician was not a

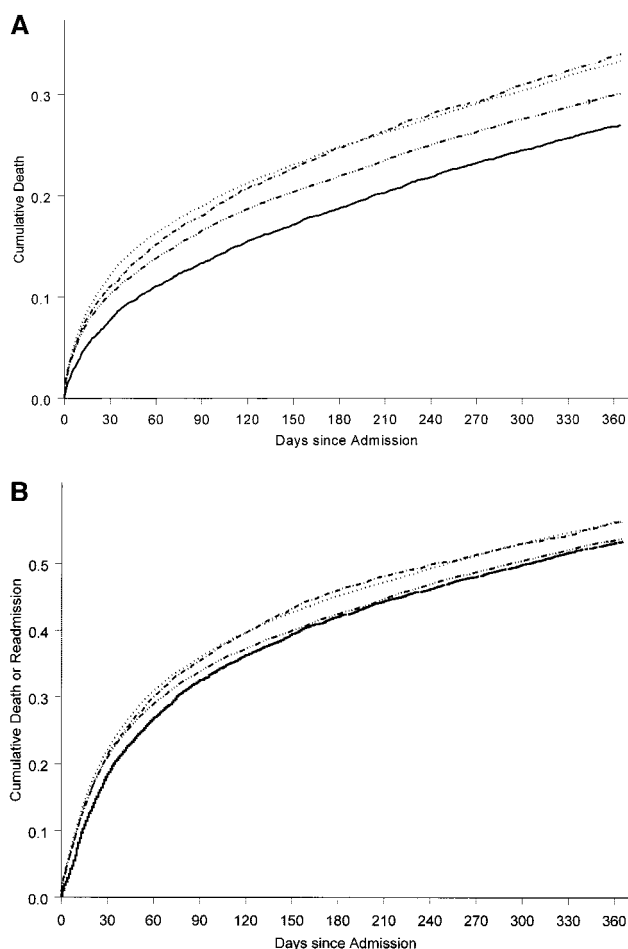
cardiologist on chart abstraction, concordant classification of the most responsible physician by CIHI was observed in 841 cases (98%).

### Discussion

Our study showed that patients with first-time admissions for heart failure in the community attended by cardiologists in hospital had lower mortality risk as well as composite risk of death and readmission for heart failure than those attended by physicians of other disciplines. Cardiologist care was associated with more aggressive care and a higher postdischarge prescription use of heart failure medications.

No randomized study has been done that compares the clinical outcomes between cardiologist care and care delivered by other physician types in hospital for heart failure. In this context, our data sharply contrast with previous observational studies<sup>4,5,22</sup> that did not demonstrate a significant specialty-related variation in mortality among patients hospitalized for heart failure. Such a discrepancy may be partly explained by differences between studies in patient selection, targeted processes of care, or duration of follow-up. Moreover, cohort studies<sup>7,23,24</sup> that compared care between medical specialties in teaching hospitals might not detect the heterogeneity that would otherwise be observed in community practice. Presumably, generalists attending in teaching hospitals would adhere more closely to evidence-based care than generalists in the community, therefore lessening the chance





Adjusted 1-year cumulative outcomes after hospitalization for heart failure in patients managed by different physician specialties. Rates have been adjusted for age, sex, comorbidities, and type of institution factors. Proportional hazards models showed that the physician specialty effect was significant for both mortality ( $\chi^2=142.9$ ,  $P<0.001$ ) and the composite outcome of death or readmission ( $\chi^2=61.49$ ,  $P<0.001$ ). — indicates cardiologists; ·····, general internists; ·····, family practitioners; and ·-·-·, other physicians.

of finding a difference that would be attributed to variation between physician groups. By including a wide range of both teaching and community hospitals in our study, we were able to detect a wider disparity in practice pattern that would be anticipated to influence clinical outcomes. Our study is therefore more consistent with existing evidence outside the field of heart failure, which has suggested that cardiology specialty care is superior to generalist care in managing acute cardiac illnesses such as myocardial infarction<sup>25</sup> and unstable angina.<sup>26</sup>

The benefits seen with cardiologist care in our study were unlikely confounded by a selection bias with cardiologists “cherry-picking” low-risk patients. We showed that the mortality advantage in favor of cardiologist care was actually more evident among higher- than lower-risk subgroups of heart failure patients. Instead, the observed gradient in outcomes supports the hypothesis that subspecialty cardiologist care may be most beneficial in patients with complicated

heart failure who carry the highest mortality risk. Similarly, the benefits of cardiologist care persisted after adjustment for hospital types and sizes, where resource differences may lead cardiologists from teaching hospitals to choose more invasive interventions than noncardiologists from community hospitals when caring for heart failure patients.

Our seemingly paradoxical finding of lower mortality but higher readmission among patients managed by cardiologists compared with other physicians may be the consequence of a survivor bias,<sup>27</sup> because only subjects who survived the index hospitalization could be at risk for subsequent readmission. Surviving subjects of cardiologists who may not otherwise survive under other physicians’ care are at high risk of additional heart failure exacerbation, even when optimal care is delivered. Our finding may also reflect the subsequent lower threshold for hospital admission among patients treated by cardiologists.

Although it was not the focus of this study to identify specific process-outcome links that would support the superiority of cardiologist care, one source for the specialty-related differences in outcomes may be related to differences in specialty-driven processes of care.<sup>28</sup> Cardiologists have reported practices that conform more closely with published guidelines for heart failure management than internists and family practitioners.<sup>3</sup> The greater use of cardiac catheterization by cardiologists than noncardiologists<sup>29</sup> is in accord with practice guidelines to identify reversible causes of heart failure and select patients in whom revascularization may improve survival. Our finding of a higher use of ACE inhibitors and  $\beta$ -blockers among cardiologists’ patients concurred with other reports,<sup>4,5,29</sup> even though our study took place in the mid 1990s, before the publication of large-scale clinical trials that demonstrated the benefits of  $\beta$ -blockade in the heart failure population.

We could not exclude the possibility that differences in specialty and nonspecialty care received in the outpatient setting might be responsible for the improved 1-year prognosis among our cardiologists’ patients compared with patients of other physician groups. Disease management programs (eg, heart function clinics) that involve specialized follow-up by multidisciplinary teams have been shown to reduce hospitalizations in heart failure patients.<sup>30</sup> Among heart failure patients managed in the outpatient setting, subspecialty care by cardiologists is associated with lower risks of death and hospitalization compared with general medicine and primary care.<sup>29,31</sup> Yet we showed that the benefits associated with cardiologist care were most pronounced during the index hospitalization period. Thereafter, the relative benefits of cardiologist care compared with noncardiologist care diminished over time. This would suggest that the differences in long-term outcomes between patients attended by different physician groups in our study were more strongly associated with differences in care given in hospital than care given in the postdischarge period.

Economic constraint and limited access to cardiologists are both barriers to universal subspecialty care for all patients with heart failure. As such, our data should not be taken as a motion toward exclusive cardiologist care for all heart failure patients. Rather, this study raises the hypothesis that specific

**TABLE 3. Comparison of Crude and Adjusted Outcomes Between Patients Managed by Different Physician Specialties\***

Outcome	Cardiologists	General Internists	Family Practitioners	Other Physicians
<b>Mortality</b>				
In hospital, %	5.5 (6.5)	8.6 (8.9)	11.0 (10.4)	10.9 (10.5)
		$P<0.001$	$P<0.001$	$P<0.001$
1 Month, %	7.5 (8.5)	10.9 (11.1)	13.5 (12.8)	12.4 (11.9)
		$P<0.001$	$P<0.001$	$P<0.001$
1 Year, %	25.9 (28.5)	31.3 (31.7)	36.3 (34.9)	37.1 (35.9)
		$P<0.001$	$P<0.001$	$P<0.001$
<b>No. of readmission per patient-year†</b>				
1 Month	0.14 (0.14)	0.14 (0.14)	0.14 (0.15)	0.13 (0.13)
		$P=0.49$	$P=0.51$	$P=0.59$
1 Year	0.77 (0.76)	0.70 (0.70)	0.73 (0.73)	0.72 (0.70)
		$P=0.004$	$P=0.07$	$P=0.02$
<b>Composite of death or readmission†</b>				
1 Month, %	18.2 (19.3)	21.7 (21.9)	23.6 (23.2)	22.9 (22.2)
		$P<0.001$	$P<0.001$	$P<0.001$
1 Year, %	52.8 (54.7)	55.1 (55.4)	58.9 (58.1)	59.3 (58.3)
		$P=0.39$	$P<0.001$	$P<0.001$

\*Risk-adjusted rates are enclosed in parentheses.  $P$  values are given for pairwise comparisons of adjusted rates against cardiologists.

†Among survivors of index hospitalization.

specialty-related differences in processes of care may partially explain the observed disparity in clinical outcomes. Although the magnitude of this disparity was only modest (as judged by the modest relative odds for adverse outcomes observed between cardiologists and noncardiologists), the impact of this disparity might still be significant because of the large number of heart failure patients hospitalized each year in the community and the proportionately large contribution of generalists compared with specialists in their care.

The reliability of coding of the CIHI database<sup>32</sup> is comparable with other administrative databases from the United States<sup>33,34</sup> used in heart failure research. Furthermore, we showed that the diagnosis of heart failure in our cohort could be confirmed in approximately 95% of the cases using the Framingham heart failure criteria. In more than 90% of the verifiable cases, the medical specialty of the most responsible physician on the discharge abstract also corresponded with that of the discharging physician recorded by chart reabstrac-

tion. The coding of the Ontario Drug Benefit database has been reported by others to be >99% accurate.<sup>12</sup>

Several limitations of our study should be noted. First, the use of administrative data necessarily restricted the collection of clinical variables that might provide better case-mix adjustment. In particular, undercoding of hypertension in the discharge abstracts limited accurate estimates of the prevalence of hypertension, a common cause of diastolic heart failure, in our population. Likewise, data on ejection fractions were not available. However, it is known that proportionally more patients of cardiologists have systolic dysfunction compared with generalists.<sup>7,23,29</sup> Because survival is better with diastolic than systolic dysfunction,<sup>35</sup> adjusting for ejection fraction may only magnify and not diminish the already disparate mortality observed between the physician groups. As in the case for all observational studies, a potential exists for unmeasured confounders that may bias our results. Second, the reliance

**TABLE 4. Stratified Analysis on 1-Year Mortality Between Patients Managed by Different Physician Specialties Based on Patient Risk\***

Risk Group	n	Expected Mortality, %	Cardiologists, %	General Internists, %	Family Practitioners, %	Other Physicians, %	Overall $P$
Low risk: age <75 y, Charlson <2	4340	16.9	14.4	15.9	14.9	18.4	0.27
Medium low risk: age <75 y, Charlson ≥2	1630	24.5	22.7	23.9	36.3	29.8	<0.0001
Medium high risk: age ≥75 y, Charlson <2	23 282	32.5	24.7	29.6	33.9	34.1	<0.0001
High risk: age ≥75 y, Charlson ≥2	9450	43.6	39.9	44.6	49.4	51.4	<0.0001

\*Risk groups were defined a priori by age and Charlson comorbidity score.<sup>11</sup>

**TABLE 5. Adjusted Odds Ratios for Adverse Outcomes Comparing Other Specialists Against Cardiologists\***

Outcome	Cardiologists	General Internists		Family Practitioners		Other Physicians	
	OR	OR	95% CI	OR	95% CI	OR	95% CI
Mortality							
In hospital	1.00	1.44	1.21 to 1.71	1.80	1.52 to 2.14	1.78	1.49 to 2.13
			<i>P</i> <0.001		<i>P</i> <0.001		<i>P</i> <0.001
1 Month	1.00	1.30	1.13 to 1.49	1.51	1.31 to 1.74	1.43	1.24 to 1.66
			<i>P</i> =0.001		<i>P</i> <0.001		<i>P</i> <0.001
1 Year	1.00	1.16	1.06 to 1.27	1.44	1.30 to 1.59	1.40	1.27 to 1.54
			<i>P</i> =0.002		<i>P</i> <0.001		<i>P</i> <0.001
Composite of death or readmission*							
1 Month	1.00	1.14	1.02 to 1.27	1.16	1.04 to 1.30	1.21	1.09 to 1.35
			<i>P</i> =0.02		<i>P</i> =0.009		<i>P</i> =0.001
1 Year	1.00	1.04	0.96 to 1.12	1.16	1.07 to 1.27	1.14	1.03 to 1.25
			<i>P</i> =0.32		<i>P</i> =0.001		<i>P</i> =0.01

\*Among survivors of index hospitalization.

on International Classification of Disease codes from discharge abstracts alone might result in underenumeration of heart failure cases that we sought to capture. Third, no information was available on the proportion of patients who had appropriate indication but did not receive a particular treatment. Finally, prescription use data were only available for patients aged 65 years or older, although this group accounted for 85% of our cohort.

In conclusion, our study showed that patients newly hospitalized for heart failure attended by cardiologists had lower mortality and lower composite risk of death and heart failure readmission compared with patients attended by physicians of other disciplines. These data raise the need to identify specific differences in processes of care between cardiologists and noncardiologists that may be responsible for the observed specialty-related disparity in heart failure outcomes.

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