Quality of Care and Outcomes of Older Patients With Heart Failure Hospitalized in the United States and Canada

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Background: Health care expenditure per person is significantly higher in the United States compared with Canada, but whether there are differences in quality of care of many conditions is unknown. We compared the process of care and outcomes of patients with heart failure, the most common cause of hospitalization for individuals 65 years and older in both countries.

Methods: We compared processes of care and 30-day and 1-year risk-standardized mortality rates among 28 521 US Medicare beneficiaries and 8180 similarly aged patients in Ontario, Canada, hospitalized with heart failure from 1998 to 2001.

Results: More US patients underwent left ventricular ejection fraction assessment during hospitalization compared with Canadian patients (61.2% vs 41.7%, $P<.001$). At discharge, patients in the United States were prescribed β-blockers more frequently (28.7% vs 25.4%, $P<.001$) but angiotensin-converting enzyme inhibitors less frequently (54.3% vs 63.4%, $P<.001$). Among ideal candidates, prescription of β-blockers (32.5% vs 29.7%, $P=.08$) or angiotensin-converting enzyme inhibitors (78.3% vs 77.6%, $P=.68$) was not significantly different between the 2 countries. The US patients had lower risk characteristics on admission and lower crude mortality rates at 30 days and 1 year. Thirty-day risk-standardized mortality was significantly lower for the US patients (8.9% vs 10.7%, $P<.001$), but 1-year risk-standardized mortality was no longer significantly different (32.2% vs 32.3%, $P=.98$).

Conclusion: Patients with heart failure who are hospitalized in the United States had lower short-term mortality at 30 days, but 1-year mortality rates were not significantly different between the United States and Canada.

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DESPITE SIMILAR CULTURE, economy, and geography, the United States and Canada have different methods of financing and providing health care. The US market-oriented system with limited governmental control is in sharp contrast to Canada's single-payer system, which covers most physician and hospital services and prescription medications.[1-4] Per capita health care costs are considerably lower in Canada than in the United States,[5,6] but Canadian budgetary restraints have resulted in limited access to specialized care, such as invasive cardiac procedures and physician specialists.[4] In contrast, the supply of specialized health care is greater in the United States, but many challenges exist in the United States, including lack of health care access for many uninsured patients and lack of prescription drugs for elderly and chronically ill patients.[7,8]

Previous comparison studies of the United States and Canada have demonstrated that patients with acute myocardial infarction who are treated in the United States are more likely to undergo invasive cardiac procedures and have similar intermediate survival rates and better long-term survival rates.[9-12] Little is known about the care and outcomes in chronic conditions with substantial public health impact. Heart failure (HF) is an important condition to study because it affects millions of Americans and Canadians,[13,14] and the long-term outcomes of HF patients are extremely poor, with 1-year mortality rates after hospitalization estimated to be 25% to 40%.[13-16] Evaluating the patterns of care and outcomes of HF patients treated in both countries may provide insights about the relative performance of these 2 health care systems. Accordingly, we compared the care and outcomes of population-based samples of elderly Americans and Canadians who were hospitalized with HF.

METHODS

NATIONAL HEART FAILURE PROJECT

The National Heart Failure Project is a Centers for Medicare and Medicaid Services initiative to improve the quality of care of Medicare beneficiaries hospitalized with HF in the United States.[17,18] Briefly, Medicare fee-for-service beneficiaries hospitalized from March 1998 to April 1999 and March 2000 to April 2001 with a principal discharge diagnosis of HF (*International Classification of Diseases, Ninth Revision, Clinical Modification* [*ICD-9-CM*] codes 402.01, 402.11, 402.91, 404.01, 404.91, or 428) were identified.

ENHANCED FEEDBACK FOR EFFECTIVE CARDIAC TREATMENT PROJECT

The Enhanced Feedback for Effective Cardiac Treatment (EFFECT) Project is an ongoing initiative to improve the quality of care of patients with cardiovascular disease in Ontario.[19] Briefly, patients hospitalized from April 1999 to March 2001 with a primary diagnosis of HF were identified using the hospital discharge abstract database (*ICD-9-CM* code 428).[19,20] Only patients who met the Framingham HF criteria (based on medical record–abstracted data) were included to confirm the presence of HF on hospital admission.[21,22] A target sample of 125 medical records was randomly selected from the 103 participating hospitals in Ontario. Approximately 25% of hospitals did not reach the target, and all the hospitalization records from these hospitals between 1999 and 2001 were evaluated for study inclusion. Data reliability monitored by random medical record reabstractions has previously demonstrated high agreement for categorical variables and continuous variables.[15,19] For continuous variables used in the prediction model, the κ agreement was in excess of 0.90 (0.97 for hemoglobin, 0.97 for sodium, 0.93 for potassium, and 0.98 for creatinine).

STUDY SAMPLE

Because the US and Canadian HF cohorts were constructed separately, we further limited both samples to ensure comparability. The *ICD-9-CM* code 428 has high accuracy in identifying HF patients when compared with the Framingham criteria (82%) and clinical HF diagnosis (90%).[23] However, other non-428 codes have relatively poor accuracy, ranging from 14% to 36%.[23] Because the Framingham criteria were not used in the US cohort, we restricted our study samples to patients who were identified by *ICD-9-CM* code 428. Furthermore, we excluded patients who did not have HF on admission as indicated by variables that were common to both samples. Also, in both cohorts, we excluded patients who were younger than 65 years or older than 105 years, were transferred from another acute care institution, were undergoing long-term hemodialysis, or had an invalid Social Security number (or Ontario health card number). We excluded patients who had been hospitalized with HF in the previous year in the United States or within the previous 3 years in Canada, because we did not have previous hospitalization information in the United States beyond 1 year.

PROCESS OF CARE AND MORTALITY

Both projects abstracted data from clinical records, such as assessment of left ventricular ejection fraction (LVEF) and prescription of evidence-based medications at hospital discharge.[24] In the United States, mortality rates after hospital admission were assessed using the Medicare Enrollment Database.[25] In Canada, the Ontario Registered Persons Database was used, which contains information on the vital status of all Ontario residents.[26]

STATISTICAL ANALYSIS

We compared demographic and clinical characteristics and the prescription of medical therapies with χ^2 tests for categorical variables and nonparametric tests for continuous variables. Statistical calculations were performed separately because of privacy restrictions in both the United States and Canada that prohibit the transfer of these data out of each jurisdiction; tests for differences were performed using the summary data for each cohort.

To account for differences in baseline risk, we first calculated the 30-day and 1-year EFFECT Project HF mortality risk scores that have been previously validated to predict mortality after an HF hospitalization.[15] Prediction was based on age, admission characteristics (systolic blood pressure, respiratory rate, and serum sodium, urea nitrogen, and hemoglobin levels), and comorbid conditions (cerebrovascular disease, dementia, chronic obstructive pulmonary disease, hepatic cirrhosis, and cancer).[15] We then separated patients into different risk strata on the basis of their risk scores; because patients within each risk stratum had approximately equal risk scores, they also had approximately equal predicted mortality rates. We calculated direct standardized Canadian mortality rates by multiplying the prevalence of US patients in each risk score stratum by the Canadian mortality rate in the corresponding stratum. This method allows estimation of mortality rates that would be expected in Canada if it were to have the same risk distribution as the United States, thus enabling us to adjust for differences in risk without combining our data sets.

A series of analyses were undertaken to examine the robustness of our results. First, owing to the concern that other potential confounding factors may have influenced our results, we evaluated other patient factors (previous myocardial infarction, hypertension, diabetes mellitus) and hospital factors (teaching hospital, hospital size) on the basis of the literature and our clinical experience. We also examined serum creatinine level as a potential explanatory variable, but it was not selected because of its high correlation and less predictive ability when compared with blood urea nitrogen level. We repeated our analyses with revised 30-day and 1-year mortality risk scores, incorporating factors that were significantly associated with mortality after hospitalization. Second, our initial analysis was performed again, replacing missing values with median values for variables used to compose the mortality risk scores. For most variables included in the prediction model, less than 1% of the data were missing. In the United States, rates of missing data were as follows: serum sodium, 1.8%; blood urea nitrogen, 2.2%; and hematocrit, 4.0%; in Canada, rates of missing data were as follows: respiratory rate, 4.7%; serum sodium, 1.8%; blood urea nitrogen, 8.1%; and hematocrit, 2.2%. We repeated our analysis, excluding patients with any missing values. Third, we performed an analysis that included only patients with severe HF and radiographic evidence of HF. These additional analyses produced results similar to those of our original approach. We conducted statistical analyses with SAS statistical software, version 8 (SAS Institute Inc, Cary, NC) and direct standardized mortality calculation with Stata statistical software, version 7.0 (StataCorp LP, College Station, Tex).

RESULTS

STUDY SAMPLES

The exclusion criteria of the study samples are detailed in **Table 1**. The final US study sample included 28 521

Table 1. Definition of Study Samples in the United States and Canada*

Description	United States	Canada
Initial sample	78 882	9945
Exclusions		
Age ≤65 or >105 y	7917	1677
Previous heart failure hospitalization†	37 787	*
Subsequent admissions during the study period	3732	*
Transferred from other institutions	1549	*
Hemodialysis	549	137
No heart failure on hospital admission	4902	*
Unable to determine mortality	969	2
Unable to determine previous hospitalization	3421	*
International Classification of Diseases, Ninth Revision, Clinical Modification code not 428	5845	
Final study sample	28 521	8180

*Patients had been excluded before clinical medical record abstraction; therefore, the exact number was unknown.
†The US cohort excluded patients with previous heart failure hospitalization within the past year, and the Canadian cohort excluded patients with previous heart failure hospitalization within the past 3 years.

patients, and the Canadian sample included 8180 patients.

CLINICAL, PHYSICIAN, AND HOSPITAL CHARACTERISTICS

The mean patient age was 80 years in both cohorts, and the US cohort had a slightly greater proportion of women (**Table 2**). Most admission characteristics and clinical comorbidities were similar between the cohorts. However, there were higher rates of hypertension and previous coronary artery bypass surgery in the United States and higher rates of previous myocardial infarction among patients in Canada (Table 2).

A greater proportion of the US cohort was admitted to teaching hospitals and hospitals with larger capacity. Cardiologists were the attending physicians for similar proportions of patients in both countries (Table 2). On average, the US cohort had a shorter hospital length of stay (mean, 6.1 days vs 8.5 days; median, 5 days vs 6 days) (Table 2).

PROCESSES OF CARE AND PRESCRIPTION MEDICATIONS AT DISCHARGE

Invasive cardiac procedures were performed in a greater proportion of patients in the United States, but the overall rate of coronary revascularization was low in both cohorts (**Table 3**). The US cohort was also more likely to undergo assessment of LVEF during hospitalization (61.2% vs 41.7%, $P<.001$) (Table 3). At hospital discharge, prescription of β-blockers was slightly higher in the United States (28.7% vs 25.4%, $P<.001$), whereas the prescription of angiotensin-converting enzyme (ACE) inhibitors or angiotensin receptor blockers was slightly higher in Canada (62.2% vs 68.9%, $P<.001$) (Table 3). More patients were considered ideal candidates for ACE inhibitors (15.2% vs 10.2%, $P<.001$) and β-blockers (18.8% vs 12.1%, $P<.001$) in the United States because of higher use of LVEF assessment. Among ideal candidates, prescription of β-blockers (32.5% vs 29.7%, $P=.08$) or ACE inhibitors (78.3% vs 77.6%, $P=.68$) was not significantly different between the 2 countries.

Table 2. Patient, Physician, and Hospital Characteristics

Characteristic	United States (n = 28 521)	Canada (n = 8180)	P Value
Age, mean (SD), y	80.1 (7.7)	79.7 (7.5)	
Age group, No. (%)			<.001
65-74 y	7564 (26.5)	2206 (27.0)	
75-84 y	12 352 (43.3)	3699 (45.2)	
≥85 y	8605 (30.2)	2275 (27.8)	
Female, No. (%)	16 349 (57.3)	4365 (53.4)	<.001
Systolic blood pressure, mean (SD), mm Hg	149.2 (30.9)	148.6 (33.2)	.11
Diastolic blood pressure, mean (SD), mm Hg	79.5 (18.6)	80.3 (19.5)	<.001
Heart rate, mean (SD), per min	91.1 (23.2)	93.3 (24.9)	<.001
Blood urea nitrogen, mean (SD), mg/dL	27.5 (16.9)	29.8 (18.8)	<.001
Renal insufficiency (creatinine >2.5 mg/dL or blood urea nitrogen >40 mg/dL), No. (%)	4505 (15.8)	1571 (19.2)	<.001
Serum sodium, mean (SD), mol/L	138.6 (5.0)	138.3 (4.9)	<.001
Hematocrit, mean (SD), %	37.7 (6.0)	36.9 (6.1)	.02
Hypertension, No. (%)	17 756 (62.3)	3953 (48.3)	<.001
Diabetes, No. (%)	9727 (34.1)	2621 (32.0)	<.001
Current smoker, No. (%)	2607 (9.6)	751 (9.2)	.91
Patients with COPD who were prescribed bronchodilators, No. (%)	2701 (9.5)	721 (8.8)	.07
Previous myocardial infarction, No. (%)	7304 (25.6)	2947 (36.0)	<.001
Previous coronary artery bypass grafting, No. (%)	5510 (19.3)	854 (10.4)	<.001
Previous stroke or transient ischemic attack, No. (%)	4976 (17.4)	1440 (17.6)	.74
Dementia, No. (%)	2830 (9.9)	754 (9.2)	.06
No cardiac invasive facilities, No. (%)	10 774 (37.8)	6827 (83.5)	<.001
Nonteaching hospital, No. (%)	19 272 (67.6)	7010 (85.7)	<.001
No. of hospital beds, mean (SD)	261 (209)	175 (132)	<.001
Cardiologist as the attending physician, No. (%)	5352 (18.8)	1584 (19.4)	.22
Length of stay, mean (SD), d	6.1 (4.4)	8.5 (12.3)	<.001

Abbreviation: COPD, chronic obstructive pulmonary disease.
SI conversion factors: To convert creatinine to micromoles per liter, multiply by 88.4; to convert blood urea nitrogen to millimoles per liter, multiple by 0.357.

ESTIMATED RISK SCORES AND MORTALITY OUTCOMES

Overall, the US cohort had lower mean mortality risk scores at both 30 days (84.0 vs 93.1, $P<.001$) and at 1

Table 3. Processes of Care and Medications at Hospital Discharge

Characteristic	United States (n = 28 521)	Canada (n = 8180)	*P* Value
In-hospital cardiovascular procedures, No. (%)			
LVEF assessment	17 459 (61.2)	3414 (41.7)	<.001
Cardiac catheterization	1589 (5.6)	48 (0.59)	<.001
Percutaneous coronary intervention	163 (0.57)	4 (0.05)	<.001
Coronary artery bypass grafting	118 (0.41)	3 (0.04)	<.001
Prescribed medications at hospital discharge, No. (%)*			
Aspirin	10 790 (39.7)	2908 (40.0)	.70
β-Blockers	7803 (28.7)	1849 (25.4)	<.001
ACE inhibitors	14 756 (54.3)	4614 (63.4)	<.001
ARBs	2152 (7.9)	423 (5.8)	<.001
ACE inhibitors or ARBs	16 908 (62.2)	5014 (68.9)	<.001
Lipid-lowering medications	4525 (16.7)	1094 (15.0)	<.001

Abbreviations: ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blocker; LVEF, left ventricular ejection fraction.
*Patients who did not survive to hospital discharge or were transferred were excluded from this analysis.

year (100.9. vs 104.0, *P*<.001) compared with the Canadian cohort. In addition, a shift toward higher risk scores throughout the risk spectrum was observed in the Canadian cohort. The unadjusted mortality rates were lower in the United States at 30 days (8.9% vs 12.2%, *P*<.001) and at 1 year (32.2% vs 35.7%, *P*<.001) (**Table 4** and **Table 5**).

The US cohort had lower mortality rates within each risk stratum at 30 days compared with the Canadian cohort, and the 30-day standardized mortality rates were also lower in the United States (8.9% vs 10.7%, *P*<.001) (Table 4 and **Figure 1**). However, the US cohort had higher standardized mortality rates between 30 days and 1 year (23.3% vs 21.8%, *P*=.002). As a result, at 1 year the overall risk-standardized mortality rates between the United States and Canada were no longer significantly different (32.2% vs 32.3%, *P*=.98) (Table 5 and **Figure 2**).

COMMENT

Our study represents one of the most comprehensive comparison studies of nationally representative HF patients

Table 4. Mortality Rates at 30 Days in the United States and Canada Stratified by Risk Scores*

	United States, No. (%)		Canada, No. (%)		
Risk Score	Prevalence	Mortality	Prevalence	Mortality	*P* Value†
≤65	3756 (13.2)	56 (1.5)	746 (9.1)	17 (2.3)	.12
>65-75	4654 (16.3)	121 (2.6)	1085 (13.3)	35 (3.3)	.25
>75-85	5393 (18.9)	216 (4.0)	1458 (17.8)	84 (5.8)	.004
>85-95	4735 (16.6)	343 (7.2)	1435 (17.5)	134 (9.4)	.009
>95-105	3616 (12.7)	381 (10.5)	1159 (14.2)	146 (12.6)	.05
>105-115	2534 (8.9)	381 (15.0)	876 (10.7)	147 (16.8)	.22
>115-125	1784 (6.3)	356 (20.0)	638 (7.8)	139 (21.8)	.33
>125	2049 (7.2)	696 (34.0)	783 (9.6)	299 (38.3)	.04
Total	**28 521** (100)	**2550** (8.9)	**8180** (100)	**1001** (12.2)	
Standardized mortality rate, % (95% CI)‡		8.9 (8.6-9.3)		10.7 (10.1-11.3)	<.001

Abbreviation: CI, confidence interval.
*Risk scores were calculated on the basis of points assigned for each predictive variable in the 30-day mortality prediction model.
†*P* values compare the mortality rates within each risk group and the standardized mortality rates between the United States and Canada.
‡Standardized mortality rate of the Canadian cohort was calculated using the US risk scores as reference.

Table 5. Mortality Rates at 1 Year in the United States and Canada Stratified by Risk Scores*

	United States		Canada		
Risk Score	Prevalence	Mortality	Prevalence	Mortality	*P* Value†
≤75	3636 (12.7)	342 (9.4)	711 (8.7)	83 (11.7)	.06
>75-85	4535 (15.9)	738 (16.3)	1038 (12.7)	169 (16.3)	>.99
>85-95	5306 (18.6)	1218 (23.0)	1417 (17.3)	310 (21.9)	.39
>95-105	4859 (17.0)	1548 (31.9)	1453 (17.8)	456 (31.4)	.73
>105-115	3668 (12.9)	1465 (39.9)	1185 (14.5)	497 (42.0)	.22
>115-125	2528 (8.9)	1296 (51.3)	886 (10.8)	433 (48.9)	.22
>125-135	1829 (6.4)	1018 (55.7)	631 (7.7)	359 (56.9)	.59
>135	2160 (7.6)	1560 (72.2)	859 (10.5)	616 (71.8)	.78
Total	**28 521** (100)	**9185** (32.2)	**8180** (100)	**2923** (35.7)	
Standardized mortality rate, % (95% CI)‡		32.2 (31.7-32.7)		32.3 (31.4-33.2)	.98

Abbreviation: CI, confidence interval.
*Risk scores were calculated based on the points assigned for each predictive variable in the 1-year mortality prediction risk model.
†*P* values compare the mortality rates within each risk group and the standardized mortality rates between the United States and Canada.
‡Standardized mortality rate of the Canadian cohort was calculated using the US risk scores as reference.

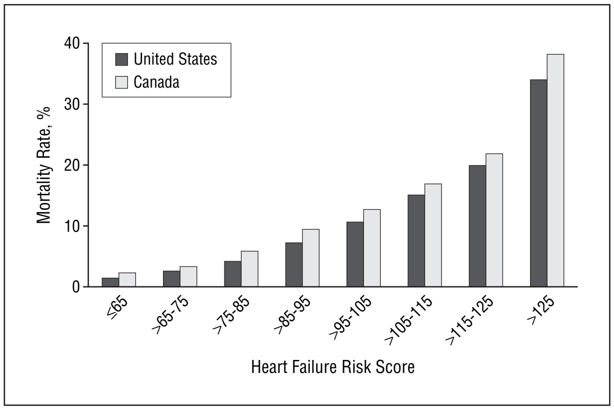

Figure 1. Mortality rates at 30 days in the United States and Canada stratified by heart failure risk scores.

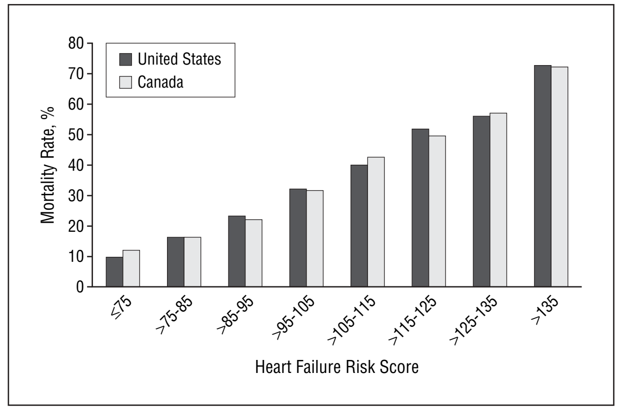

Figure 2. Mortality rates at 1 year in the United States and Canada stratified by heart failure risk scores.

in the United States and Canada. Patients hospitalized in the United States were more likely to have assessment of LVEF, whereas prescription of evidence-based medication, such as β-blockers and ACE inhibitors, was not substantially different compared with Canada. Standardized mortality at 30 days, which may reflect differences in care during hospitalization, was significantly lower in the United States. These early mortality benefits that favor the US cohort, however, dissipated over time. At 1 year after HF hospitalization, the standardized mortality rates for patients treated in the 2 countries were no longer significantly different. Although we observed important differences in processes of inpatient care, they did not appear to fully account for the observed outcomes.

To evaluate the level of HF care provided by each country, we examined quality-of-care measures, such as assessment of LVEF and prescription of evidence-based therapies at hospital discharge.[24] Although we did not have information on outpatient use of β-blockers or ACE inhibitors, evidence suggests that therapies are unlikely to be initiated in the outpatient setting and prescription at hospital discharge is strongly associated with long-term use.[27-29] Even after accounting for the 11% of patients who had LVEF assessment in the preceding 6 months and the 2% who had planned LVEF assessment after hospital discharge, the proportion of patients who had LVEF assessment in Canada was still significantly lower compared with the United States. It has been demonstrated that LVEF assessment is more likely to be performed in hospitals with advanced cardiac capabilities.[30] Because we observed that Canadian hospitals were smaller and less often had cardiac invasive facilities compared with US hospitals, fewer LVEF measurements in Canadian HF patients might be explained by resource limitations. However, despite differences in the use of LVEF assessment, we did not observe substantial differences in the overall prescription of potentially life-saving therapies, such as β-blockers or ACE inhibitors. In both countries, a considerable number of elderly patients were prescribed neither therapy despite the proven benefits, suggesting an opportunity to improve the care of HF patients regardless of where they are treated.[31,32]

Patients with HF hospitalized in Canada had clinical characteristics associated with higher risk scores, indicating worse predicted outcomes on average compared with patients in the United States. Similarly, a previous investigation[10] demonstrated that patients with acute myocardial infarction admitted to intensive care units in Canada have higher risk characteristics compared with their US counterparts. This observation was attributed to fewer intensive care beds in Canada that translated into a higher threshold for admission to intensive care units. It is well recognized that hospital downsizing during the 1990s owing to federal budget deficits created a strain on the Canadian health care system.[4,33] As a result, Canadian physicians, who are more likely to face long-term hospital bed shortages, may rationalize each admission decision in view of the local bed situation. This difference in resource availability likely translated into Canadian physicians admitting higher-risk HF patients while not hospitalizing some lower-risk patients who would have been hospitalized in the United States.

Even after accounting for the higher risk profiles of the Canadian cohort, hospitalized HF patients in the United States had significantly lower short-term mortality rates. This may relate to the intensity and timeliness of US hospital care. Previous studies[6] demonstrated that waiting time for many diagnostic and therapeutic procedures is shorter in the United States, which may also partly explain an average shorter length of hospital stay of 2 days in the US cohort. Furthermore, a more aggressive approach has been repeatedly demonstrated in patients with cardiovascular disease treated in the United States, which is consistent with our observation of a markedly higher use of invasive cardiac procedures in HF patients hospitalized in the United States. It has been demonstrated that US patients with acute myocardial infarction are more frequently admitted to intensive care units, are treated more frequently with invasive cardiac interventions, and are more likely to be transferred to other hospitals for further treatment.[9-11] Many aspects of in-hospital treatment were not abstracted because of the knowledge gap in understanding what processes of care during a hospitalization for HF are associated with improved outcomes.

Despite lower short-term mortality rates in the US cohort, risk-standardized mortality rates were higher in the United States beyond 30 days, and therefore these early mortality benefits were not sustained at 1 year. The phenomenon of better short-term survival rates in the United States followed by equivalent long-term survival rates in both countries has also been previously observed in the setting of acute myocardial infarction and postsurgical patients.[9,34] We could not assess the possible reasons for this finding, but differences in health care provision in the 2 countries may play an important role. It is plausible that better short-term outcomes in the United States may relate to the intensity of hospital care, and the similar long-term outcomes between the countries may reflect better access in Canada to outpatient follow-up and prescription drugs, which are universally covered in the Canadian health care system.[4,9,35,36]

Although we were unable to fully explain the observed mortality pattern, some hypotheses may be discounted. First, it is unlikely that it was secondary to the use of evidence-based therapies at hospital discharge, because the US and Canadian patients had similar discharge prescription rates. Second, recent evidence has suggested that HF patients who are attended to by cardiologists have lower mortality rates.[37] However, patients were attended to by cardiologists at similar frequencies in both cohorts. Third, differences in coronary revascularization are unlikely to explain the disparity in mortality rates. Despite higher utilization rates in the United States, less than 1% of the overall US cohort underwent revascularization with either percutaneous coronary intervention or coronary artery bypass grafting. Furthermore, the mortality benefits of revascularization in these elderly patients have not been proved.

Several limitations of our study merit consideration. First, we were unable to combine data from the 2 cohorts to calculate adjusted mortality rates, because privacy restrictions in both countries did not allow transfer of patient-level data outside each jurisdiction. However, both databases contained similar detailed information on patients' demographic, admission, and clinical characteristics. Using previously validated mortality risk scores, we were able to stratify patients into similar risk groups and calculate standardized mortality rates accounting for baseline risk of patients between the countries. In fact, previous landmark studies that compared patients with acute myocardial infarction treated in both countries used a similar analytical approach.[9] We were unable to perform hierarchical modeling to compare processes of care between the 2 countries. However, hierarchical modeling tends to produce more conservative estimates, and therefore it is unlikely that it would have changed our observation that the use of medical therapy was not substantially different. Second, we were unable to standardize the duration of previous hospitalization across the 2 databases. This difference occurred because of different sample designs when the 2 cohorts were constructed separately. However, this lead-time bias would tend to capture more advanced, or "sicker," HF patients in the United States compared with Canada, where patients would have less advanced HF, and would tend to diminish our findings. Finally, we were unable to compare quality of care and outcomes of uninsured HF patients in the United States, because we had information on Medicare beneficiaries only. However, most HF cases (>80%) in the United States occur in persons 65 years or older.[38]

In conclusion, we found that HF patients hospitalized in the United States had significantly better short-term mortality but equivalent long-term mortality compared with a sample of HF patients hospitalized in Canada. Further studies are needed to explore the reasons underlying this difference in outcomes and to gain additional insights to improve the care and outcomes of HF patients in both countries.

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