JAMA Cardiology | Original Investigation

Trends in Readmissions and Length of Stay for Patients Hospitalized With Heart Failure in Canada and the United States

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Invited Commentary

Supplemental content

IMPORTANCE Over the past decade, reducing 30-day readmission rates has been emphasized in the United States (including via the implementation of the Hospital Readmissions Reduction Program) but not Canada.

OBJECTIVE To examine changes that occurred from April 1, 2005, to December 31, 2015, in the United States and Canada for hospitalization length of stay and 30-day readmission rates of patients with heart failure.

DESIGN, SETTING, AND PARTICIPANTS This cohort study included patients admitted with a primary diagnosis of heart failure to Canadian and US hospitals between April 1, 2005, and December 31, 2015, using *International Classification of Diseases, Ninth Revision* code 428.xx and *Tenth Revision* code I50. The study examined secular trends in length of stay and readmissions in both countries and tested for changes after implementation of the Hospital Readmissions Reduction Program using segmented regression models and the association between length of stay and readmissions using patient-level and hospital-level multivariable logistic regression models. Data analysis was completed from February 2018 to August 2018.

MAIN OUTCOMES AND MEASURES Thirty-day readmissions.

RESULTS Between 2005 and 2015, mean length of stay declined marginally in Canadian hospitals (from a mean [SD] of 7.5 [5.7] to 7.3 [5.6] days; $P < .001$) but remained stable in US hospitals (mean [SD], 4.9 [3.7] days to 4.9 [3.5] days). Thirty-day readmission rates declined similarly in Canada (from 4088 of 20 758 patients [19.7%] to 3823 of 21 733 patients [17.6%] for all-cause readmissions; $P < .001$; and from 1743 of 20 758 patients [8.4%] to 1490 of 21 733 patients [6.9%] for heart failure–specific readmissions; $P < .001$) and the United States (from 21.2% to 18.5% for all-cause readmissions; from 7.6% to 5.7% for heart failure–specific readmissions; both $P < .001$). There were small but statistically significant positive correlations between length of stay and 30-day readmissions in both Canada (odds ratio, 1.01 [95% CI, 1.01-1.01]) and the United States (odds ratio, 1.01 [95% CI, 1.01-1.01]). Interrupted time-series analysis comparing readmission rates before and after the Hospital Readmissions Reduction Program implementation revealed no significant difference in either country for all-cause readmission rates before and after October 2012. There was also no change in the slope of the temporal trends; in Canada, all-cause readmissions were decreasing 1.1% per year before implementation and 1.3% after implementation ($P = .84$ for slope change) compared with 1.6% per year in the United States before implementation and 1.8% per year after October 2012 ($P = .60$ for slope change).

CONCLUSIONS AND RELEVANCE Both Canada and the United States exhibited similar temporal declines in 30-day all-cause readmissions over the past decade. These findings suggest that the Hospital Readmissions Reduction Program did not appear to be associated with this secular trend or length of stay for heart failure in the United States.

JAMA Cardiol. doi:10.1001/jamacardio.2019.0766
Published online April 10, 2019.

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Canada and the United States have health care systems that are relatively expensive compared with other developed nations.[1] Nearly 80% of this cost is associated with inpatient care.[2] In an effort to reduce these costs, there has been an increasing emphasis on reducing 30-day readmission rates in the United States. For instance, under the Patient Protection and Affordable Care Act of 2010, the Centers for Medicare & Medicaid Services implemented the Hospital Readmissions Reduction Program (HRRP) in October 2012, which included payment penalties for US hospitals deemed to have excessive readmission rates for patients who were Medicare beneficiaries and had heart failure (HF), myocardial infarction, or pneumonia.[3] In Canada, all hospitals are publicly funded and are not subject to financial penalties based on readmission rates.

Heart failure, one of the most common reasons for hospitalization in North America, is also one of the few cardiovascular conditions with an increasing prevalence.[4] Although prognosis for patients with HF has improved in the past decade, the risks of death or hospitalization are high and continuing to increase.[5] Several recent studies have reported conflicting results on the association between lengths of stay (LOS) for hospitalized patients with HF and rates of readmission within 30 days of discharge.[6-10] Because there is no equivalent to the HRRP in Canada, we conducted this study to examine recent trends (between 2005 and 2015) in Canada and the United States for LOS and 30-day readmission rates for patients hospitalized with a primary diagnosis of HF.

Key Points

Question After the 2010 implementation of the Hospital Readmissions Reduction Program in the United States, how have hospital length of stay and 30-day readmission rates for patients with heart failure changed in the United States and Canada, where no such program was enacted?

Findings In this cohort study, the mean length of stay changed marginally in Canada and remained stable in the United States from 2005 through 2015. Thirty-day readmission rates declined by 2.1% in Canada and 2.7% in the United States for all-cause readmissions and by 1.5% in Canada and 1.9% in the United States for heart failure–specific readmissions; there was a weak positive correlation between index length of stay and 30-day readmission rates.

Meaning Implementation of the Hospital Readmissions Reduction Program was not associated with changes in length of stay for patients with heart failure in the United States between 2005 and 2015, and the reductions in all-cause 30-day readmission rates in the United States were similar to those in Canada in the same time span.

Methods

Study Samples

We used the Canadian Institute of Health Information Discharge Abstract Database (CIHI-DAD) to examine all acute care hospitalizations in 9 Canadian provinces and 3 territories with a primary diagnosis of HF using *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10)* code I50, which had previously been shown to be accurate for HF when validated against medical record audit with 93% positive predictive value.[11] We included data from April 1, 2005, to December 31, 2015. The CIHI-DAD includes the admission date, discharge dates, acuity, primary diagnosis assigned by the attending physician, and up to 24 other diagnoses coded by trained nosologists using standard definitions and physician-assigned diagnoses in each hospital. For the US cohort, we used the Medicare Hospitalization files to examine all acute care hospitalizations with a primary diagnosis of HF, using *International Classification of Diseases, Ninth Revision (ICD-9)* code 428.xx before September 30, 2015, and *ICD-10* code I50 after October 1, 2015.

Ethics approval was obtained from the Health Research Ethics Boards at the University of Alberta and Duke University. Both boards waived the requirement for informed consent, given the anonymized nature of the data analyzed.

For patients admitted multiple times in the study years, we selected the first hospitalization per patient. We excluded any patients admitted to hospitals with less than 25 HF discharges over the 10 years studied and excluded any patients with less than 1 year of insurance coverage via Medicare or data entered into the CIHI-DAD prior to the index hospitalization.

We excluded patients who were younger than 20 years, died during the index hospitalization, were hospitalized for longer than 30 days, were transferred between acute care hospitals or to a hospice, or signed themselves out against medical advice. Thus, we analyzed a cohort of adult patients discharged alive after a hospitalization for HF. In a sensitivity analysis, we restricted the cohort to patients 65 years or older.

Covariates

Comorbidities for each patient were identified using *ICD-9* (for the US Medicare data before October 1, 2015) or *ICD-10* codes (for the US Medicare data after October 1, 2015, and the CIHI-DAD for all years) for the index hospitalization and any hospitalizations in the 12 months prior.[11] Other covariates included type of hospital (teaching vs nonteaching), patient residence (rural vs urban), number of hospitalizations in the prior 6 months, and day of discharge (since this influenced readmission rates in other studies[12]). In the Canadian data only, we were also able to adjust for specialty of the most responsible physician (ie, cardiologist, other internal medicine specialist, family physician, other). Because it did not appreciably change the adjusted odds ratios compared with analyses not including physician specialty, we report the multivariable analyses without physician specialty.

Outcomes

The outcomes of interest were index hospitalization LOS, 30-day all-cause readmission rates (from time of discharge), and 30-day HF-specific readmission rates. We also examined 30-day noncardiovascular readmission rates and total inpatient days of care in the 30 days after the index admission (incorporating both the index LOS and any days for subsequent readmissions, up to 30 days). Of note, we did not have access to out-of-hospital deaths after discharge in either the Canadian or US data. However, a prior study[12] in the Canadian province of Alberta revealed that this occurred in less than 3% of discharged patients within 30 days; almost all of these deaths occurred in the emergency department or inpatient ward during a second hospitalization (and thus would have been captured in our readmission data), such that less than 0.5% of patients died out of hospital within 30 days of discharge. In the same vein, an analysis of 71 231 patients receiving Medicare who were discharged from 14 Kaiser Permanente hospitals between 2011 and 2014 revealed that only 0.9% of patients died out of the hospital within 30 days of discharge.[13]

Analyses

We compared patient and hospital characteristics using Wilcoxon rank sum tests or χ^2 tests between those patients who were or were not readmitted within 30 days after discharge. We examined secular trends in outcomes in Canada and the United States separately. Cochran-Armitage tests were used for testing trend in readmission outcomes, and Cochran-Mantel-Haenszel nonzero correlation tests were used for testing trends in LOS. Given the underlying demographic differences (the Canadian CIHI-DAD data included all adults, while the Medicare hospitalization files only include those patients older than 65 years or with a disability), we compared postdischarge outcomes in subgroups defined by index hospital LOS and patient age.

To evaluate the association between LOS and readmissions, we conducted patient-level and hospital-level analyses. For the patient-level analysis, multivariable logistic regression models were used, and hospitals were treated as a random effect to account for within-hospital clustering. The adjustment variables included age, sex, Charlson Comorbidity Index score, number of hospitalizations in the prior 12 months, index disposition, index acuity (emergent vs urgent vs elective), discharge on a weekend or holiday, year of discharge, rural status, hospital type (teaching vs nonteaching), and geographical location (province in Canada and geographic regions in United States).[14] The association between LOS and readmissions was first examined using restricted cubic splines to ensure that an approximately linear relationship existed so that it was appropriate to model LOS as a single linear continuous variable.

For the hospital-level analysis, we calculated mean hospital-level LOS and readmission rates over the full period and evaluated the Pearson and Spearman correlation coefficients between mean LOS and 30-day all-cause readmissions rates. To examine the outcome of the HRRP, a segmented regression model was used to examine for level and slope changes before vs after October 1, 2012 (when the payment penalty was implemented by the Centers for Medicare and Medicaid Services). In a sensitivity analysis, we explored whether there were changes before vs after April 1, 2010 (when the Patient Protection and Affordable Care Act was passed by the US Congress). The model included a continuous time variable, a binary variable indicating after vs before the 2 points, and as we did not have complete data for the 2005 calendar year, we only incorporated data from January 1, 2006, to December 31, 2015. The analyses were conducted using SAS version 9.4 (SAS Institute). All statistical tests were 2-sided and had a significance level of .05.

Results

This study included 265 165 individuals from Canada and 2 794 579 individuals from the United States who were admitted to hospital for a primary diagnosis of HF (eFigure 1 in the Supplement). This analysis focused on the 239 031 individuals from Canada (mean [SD] age, 77.0 [12.2] years; 119 845 male [50.1%]; mean [SD] Charlson Comorbidity Index score, 4.3 [2.2]) and 2 781 829 individuals from the United States (mean [SD] age, 78.0 [11.2] years; 1 263 828 male [45.4%]; mean [SD] Charlson Comorbidity Index score, 4.7 [2.2]) discharged alive after an acute care hospitalization for HF.

Canada

In Canada, 26 134 of 265 165 patients (9.9%) hospitalized for a primary diagnosis of HF in 528 acute care hospitals died during the index hospitalization. These patients had longer LOS than those who were discharged alive (mean [SD], 8.8 [7.4] days vs 7.4 [5.7] days; $P < .001$) and were older (mean [SD], 83.0 [9.7] years vs 77.1 [12.2] years; $P < .001$), had higher comorbidity burdens (mean [SD] Charlson Comorbidity Index score, 5.2 [2.6] points; 4.3 [2.2] points; $P < .001$), had more hospitalizations in the prior 6 months (mean [SD] hospitalizations, 0.7 [1.1] vs 0.6 [1.0]; $P < .001$), were less likely to be treated at teaching hospitals (7467 of 26 134 [28.6%] vs 76 693 of 239 031 [32.1%]; $P < .001$), and were more likely to be cared for by family physicians (14 658 [56.1%] vs 113 422 [47.5%]; $P < .001$; eTable 1 in the Supplement) than patients who were discharged alive.

Of the 239 031 patients (mean [SD], age 77.0 [12.2] years; 119 845 men [50.1%]) discharged alive after an acute care hospitalization for HF (eFigure 1 in the Supplement), 43 498 (18.2%) were readmitted within 30 days. Patients who were readmitted were older than those who were not readmitted (mean [SD] age, 77.9 [11.6] years vs 76.9 [12.3] years; $P < .001$) and had higher comorbidity burdens (mean [SD] Charlson Comorbidity Index score, 4.7 [2.4] vs 4.2 [2.2]; $P < .001$), more hospitalizations in the prior 6 months (0.9 [1.2] vs 0.6 [1.0]; $P < .001$), and longer LOS during the index hospitalization (mean [SD], 7.8 [5.8] days vs 7.4 [5.6] days; $P < .001$). They were also less likely to be treated in a teaching hospital than those who were not readmitted (13 593 of 43 498 [31.2%]; 63 100 of 195 533 [32.3%]; $P < .001$; **Table 1**). Patients who were not readmitted were more frequently discharged home (27 204 [62.5%] vs 129 125 [66.0%]) or to a long-term care facility (4447 [10.2%] vs 24 641 [12.6%]) and their attending physician during their index hospitalization was more often a cardiologist (6372 [14.6%] vs 34 989 [17.9%]; $P < .001$; Table 1) than patients who were readmitted.

United States

In the United States, 109 201 of the 2 891 030 patients (3.8%) hospitalized for a primary diagnosis of HF in 4720 acute care hospitals died during the index hospitalization. These patients had longer LOS than those who were discharged alive (mean [SD], 6.2 [5.7] days vs 4.9 [3.6] days; $P < .001$) and were older (mean [SD], 82.3 [9.9] years vs 78.0 [11.2] years; $P < .001$), had higher comorbidity burdens (mean [SD] Charlson

Table 1. Baseline Characteristics Comparing Patients Readmitted vs Not Readmitted Among Those Discharged Alive

Characteristic	Canada, No. (%) Overall (n = 239 031)	Canada Readmitted Within 30 d (n = 43 498)	Canada Not Readmitted Within 30 d (n = 195 533)	Canada P Value[a]	United States, No. (%) Overall (n = 2 781 829)	United States Readmitted Within 30 d (n = 552 608)	United States Not Readmitted Within 30 d (n = 2 229 221)	United States P Value
Age at time of admission, mean (SD), y	77.1 (12.2)	77.9 (11.6)	76.9 (12.3)	<.001	78.0 (11.2)	77.7 (11.5)	78.1 (11.1)	<.001
Male	119 845 (50.1)	22 011 (50.6)	97 834 (50.0)	.03	1 263 828 (45.4)	248 952 (45.1)	1 014 876 (45.5)	<.001
Rural resident[b]	47 871 (20.1)	9078 (20.9)	38 793 (19.9)	<.001	444 329 (16.5)	81 684 (15.3)	362 645 (16.8)	<.001
Resided in long-term care facility before hospitalization	22 336 (9.3)	4230 (9.7)	18 106 (9.3)	.003	NA	NA	NA	NA
Charlson Comorbidity Index score, mean (SD)	4.3 (2.2)	4.7 (2.4)	4.2 (2.2)	<.001	4.7 (2.2)	5.0 (2.4)	4.7 (2.2)	<.001
Hospitalizations during previous 6 mo, mean (SD)	0.6 (1.0)	0.9 (1.2)	0.6 (1.0)	<.001	0.8 (1.2)	1.2 (1.5)	0.7 (1.1)	<.001
Length of stay for index hospitalization, mean (SD), d	7.4 (5.7)	7.8 (5.8)	7.4 (5.6)	<.001	4.9 (3.6)	5.5 (4.1)	4.7 (3.5)	<.001
Admission type								
Elective	5590 (2.3)	862 (2.0)	4728 (2.4)	<.001	267 484 (9.6)	35 838 (6.5)	231 646 (10.4)	<.001
Urgent	233 441 (97.7)	42 636 (98.0)	190 805 (97.6)		549 347 (19.8)	104 737 (18.9)	444 610 (20.0)	
Discharged on weekend or holiday	37 094 (15.5)	6830 (15.7)	30 264 (15.5)	.24	536 149 (19.3)	102 621 (18.6)	433 528 (19.5)	<.001
Discharge disposition								
Home	156 329 (65.4)	27 204 (62.5)	129 125 (66.0)	<.001	2 121 962 (76.3)	397 840 (72.0)	1 724 122 (77.3)	<.001
Home with home care	53 614 (22.4)	11 847 (27.2)	41 767 (21.4)		NA	NA	NA	
To long-term care or skilled nursing facility	29 088 (12.2)	4447 (10.2)	24 641 (12.6)		613 149 (22.4)	143 477 (26.0)	469 672 (21.2)	
History of congestive heart failure in year prior to index hospitalization	45 986 (19.2)	11 221 (25.8)	34 765 (17.8)	<.001	989626 (35.6)	248 382 (45.0)	741 244 (33.3)	<.001
Hypertension	110 204 (46.1)	20 748 (47.7)	89 456 (45.7)	<.001	1 282 168 (46.1)	304 525 (55.1)	977 643 (43.9)	<.001
Diabetes mellitus	91 790 (38.4)	17 896 (41.1)	73 894 (37.8)	<.001	690 573 (24.8)	172 711 (31.3)	517 862 (23.2)	<.001
Without chronic complication	NA	NA	NA	NA	505 199 (18.2)	119 348 (21.6)	385 851 (17.3)	<.001
With chronic complication	NA	NA	NA	NA	18 5374 (6.7)	53 363 (9.7)	132 011 (5.9)	<.001
Coronary artery disease[c]	84 252 (35.2)	17 053 (39.2)	67 199 (34.4)	<.001	NA	NA	NA	NA
Myocardial infarction	NA	NA	NA	NA	387 492 (13.9)	98 529 (17.8)	288 963 (13.0)	<.001
Coronary artery bypass grafting	NA	NA	NA	NA	60 120 (2.2)	12 602 (2.3)	47 518 (2.1)	<.001
Percutaneous coronary intervention	NA	NA	NA	NA	236 207 (8.5)	57 061 (10.3)	179 146 (8.0)	<.001
Peripheral arterial disease	2219 (0.9)	522 (1.2)	1697 (0.9)	<.001	56 984 (2.0)	15 749 (2.9)	41 235 (1.9)	<.001
Cerebrovascular disease[d]	6615 (2.8)	1412 (3.2)	5203 (2.7)	<.001	217 951 (7.8)	54 238 (9.8)	163 713 (7.3)	<.001
Atrial fibrillation/flutter	86 691 (36.3)	16 340 (37.6)	70 351 (36.0)	<.001	673 060 (24.2)	158 717 (28.7)	514 343 (23.1)	<.001
Ventricular arrythmias	4885 (2.0)	1030 (2.4)	3855 (2.0)	<.001	104 727 (3.8)	27 632 (5.0)	77 095 (3.5)	<.001
Chronic kidney disease	62 693 (26.2)	14 287 (32.8)	48 406 (24.8)	<.001	549 613 (19.8)	149 375 (27.0)	400 238 (18.0)	<.001
Cancer	12 735 (5.3)	3120 (7.2)	9615 (4.9)	<.001	108 414 (3.9)	28 788 (5.2)	79 626 (3.6)	<.001
Chronic obstructive pulmonary disease or asthma	53 159 (22.2)	11 319 (26.0)	41 840 (21.4)	<.001	688 062 (24.7)	177 170 (32.0)	510 892 (22.9)	<001
Peptic ulcer disease	3350 (1.4)	733 (1.7)	2617 (1.3)	<.001	50 554 (1.8)	13 317 (2.4)	37 237 (1.7)	<.001
Liver disease	3744 (1.6)	933 (2.1)	2811 (1.4)	<.001	51 504 (1.9)	14 015 (2.5)	35 172 (1.6)	<.001
Dementia	14 922 (6.2)	2736 (6.3)	12 186 (6.2)	.65	71 980 (2.6)	17 901 (3.2)	54 079 (2.4)	<.001
Teaching hospital	76 693 (32.1)	13 593 (31.2)	63 100 (32.3)	<.001	1 641 516 (61.0)	329 178 (61.7)	1 312 338 (60.8)	<.001

(continued)

Table 1. Baseline Characteristics Comparing Patients Readmitted vs Not Readmitted Among Those Discharged Alive (continued)

Characteristic	Canada, No. (%) Overall (n = 239 031)	Canada, No. (%) Readmitted Within 30 d (n = 43 498)	Canada, No. (%) Not Readmitted Within 30 d (n = 195 533)	P Value[a]	United States, No. (%) Overall (n = 2 781 829)	United States, No. (%) Readmitted Within 30 d (n = 552 608)	United States, No. (%) Not Readmitted Within 30 d (n = 2 229 221)	P Value
Primary physician type[e]								
Cardiologist	41 361 (17.3)	6372 (14.6)	34 989 (17.9)	<.001	NA	NA	NA	NA
Internal medicine other than cardiology	70 141 (29.3)	13 051 (30.0)	57 090 (29.2)		NA	NA	NA	
Family physician	113 422 (47.5)	21 418 (49.2)	92 004 (47.1)		NA	NA	NA	
Other	14 107 (5.9)	2657 (6.1)	11 450 (5.9)		NA	NA	NA	

Abbreviation: NA, not applicable.

[a] *P* Values calculated using *t* test (means) or χ^2 test (binary/categorical).

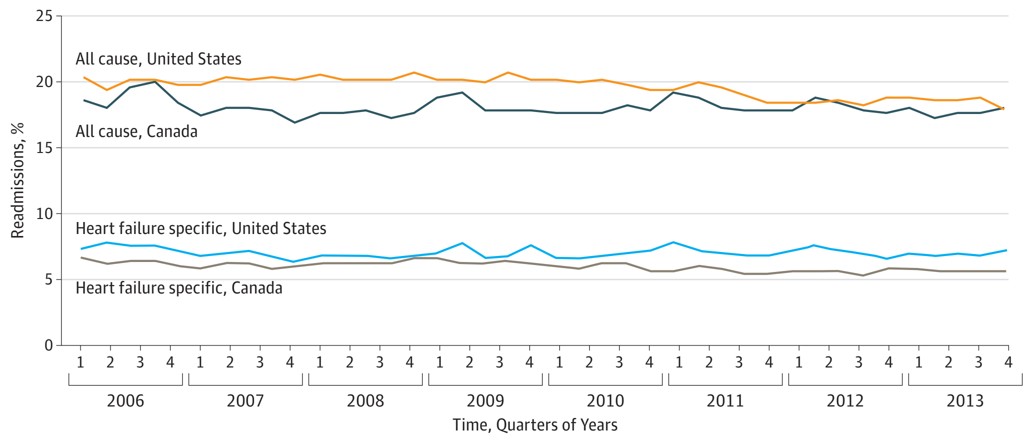
[b] A total of 227 patients (0.12%) have missing values for rural residence status.

[c] This includes prior myocardial infarction, coronary artery bypass graft, or percutaneous coronary intervention or stent.

[d] This includes previous stroke or transient ischemic attack.

[e] In the United States cohort, 30% of data were missing.

Figure. All-Cause and Heart Failure 30-day Readmission Rates by Quarter in Canada and the United States.



Comorbidity Index score, 5.0 [2.4] points vs 4.7 [2.2] points; *P* < .001) had more hospitalizations in the prior 6 months (1.0 [1.3] vs 0.8 [1.2]; *P* < .001), and were treated in a teaching hospital in fewer cases (61 815 of 109 201 [58.6%] vs 1 641 516 of 2 781 829 [61.0%]; *P* < .001; eTable 2 in the Supplement).

Of the 2 781 829 patients (mean [SD] age, 78.0 [11.2] years; 1 263 828 men [45.4%]) discharged alive after an acute care hospitalization for HF (**Figure**), 552 608 (19.9%) were readmitted within 30 days. Patients who were readmitted had higher comorbidity burdens than those were not readmitted (mean [SD] Charlson Comorbidity Index score, 5.0 [2.4] vs 4.7 [2.2]; *P* < .001), longer LOS during the index hospitalization (mean [SD], 5.5 [4.1] days vs 4.7 [3.5] days), and more hospitalizations in the prior 6 months (mean [SD] hospitalizations, 1.2 [1.5] vs 0.7 [1.1]; *P* < .001; Table 1). Patients who were readmitted were less often discharged to home than those who were not readmitted (397 840 [72.0%] vs 1 724 122 [77.3%]); *P* < .001; Table 1).

Time Trends

Canada

Between 2005 and 2015, both index hospitalization LOS and total inpatient days of care in the first 30 days significantly declined, but the magnitude of changes were small, with index LOS changing from a mean (SD) of 7.5 (5.7) days in 2005 to 7.3 (5.6) days in 2015 (*P* < .001), and total inpatient days within 30 days changing from a mean (SD) of 9.1 (7.1) days to 8.9 (7.0) days (*P* < .001; **Table 2**). All-cause 30-day readmission rates declined from 4088 of 20 758 patients (19.7%) to 3823 of 21 733 patients (17.6%) over the period, and HF-specific 30-day readmission rates declined from 1743 of 20 758 patients (8.4%) to 1490 of 21 733 patients (6.9%) (both *P* < .001; Table 2). Although index hospitalization mortality rates (24 828 deaths in 227 025 patients [10.9%]) and 30-day readmissions (37 763 in 202 197 patients [18.7%]) were approximately 1% higher in the patients older than 65 years, LOS were very similar for the older subgroup (declining from a mean [SD] of 7.6 [5.8] days to 7.4 [5.6] days over the decade).

United States

Between 2005 and 2015, index hospitalization LOS remained stable at a mean (SD) of 4.9 (3.7) days in 2005 and 4.9 (3.5) days in 2015 (*P* < .001), and total inpatient days of care in the first 30 days declined marginally from 5.9 (4.7) to 5.7 (4.4) days (*P* < .001; Table 2). All-cause 30-day readmission rates

Table 2. Changes in Length of Stay, Index Hospitalization Mortality, and Postdischarge Outcomes in Canada and the United States by Year

Variable	Patients, No. (%)										
	2005[a]	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015[a]	*P* Value[b]
Patients from Canada												
Discharged alive, No.	20 758	23 870	22 038	21 520	21 190	20 626	20 892	21 003	22 120	23 281	21 733	NA
Index hospitalization acute LOS, mean (SD), d	7.5 (5.7)	7.5 (5.7)	7.6 (5.8)	7.6 (5.7)	7.6 (5.7)	7.5 (5.7)	7.5 (5.7)	7.4 (5.6)	7.3 (5.6)	7.3 (5.5)	7.3 (5.6)	<.001
All-cause readmission within 30 d of discharge	4088 (19.7)	4531 (19.0)	3971 (18.0)	3765 (17.5)	3775 (17.8)	3759 (18.2)	3724 (17.8)	3867 (18.4)	3998 (18.1)	4197 (18.0)	3823 (17.6)	<.001
Total hospital days within 30 d of index admission, mean (SD)	9.1 (7.1)	9.2 (7.2)	9.3 (7.2)	9.2 (7.1)	9.2 (7.1)	9.2 (7.1)	9.1 (7.1)	9.1 (7.1)	8.9 (6.9)	8.9 (6.9)	8.9 (7.0)	<.001
Heart failure readmission within 30 d of discharge	1743 (8.4)	1807 (7.6)	1536 (7.0)	1435 (6.7)	1440 (6.8)	1469 (7.1)	1411 (6.8)	1521 (7.2)	1550 (7.0)	1606 (6.9)	1490 (6.9)	<.001
Cardiovascular readmission within 30 d of discharge	2139 (10.3)	2217 (9.3)	1917 (8.7)	1744 (8.1)	1815 (8.6)	1782 (8.6)	1695 (8.1)	1866 (8.9)	1858 (8.4)	1949 (8.4)	1783 (8.2)	<.001
Noncardiovascular readmission within 30 d of discharge	2169 (10.4)	2551 (10.7)	2273 (10.3)	2218 (10.3)	2161 (10.2)	2163 (10.5)	2211 (10.6)	2208 (10.5)	2328 (10.5)	2470 (10.6)	2253 (10.4)	.77
Index hospitalization mortality, No./Total No. (%)	2446/23 204 (10.5)	2955/26 825 (11.0)	2691/24 729 (10.9)	2588/24 108 (10.7)	2401/23 591 (10.2)	2252/22 878 (9.8)	2154/23 046 (9.3)	2182/23 185 (9.4)	2168/24 288 (8.9)	2181/25 462 (8.6)	2116/23 849 (8.9)	<.001
Patients from the United States												
Discharged alive, No.	322 253	348 629	291 895	264 062	253 967	241 881	231 863	214 979	210 663	209 278	192 359	NA
Index hospitalization acute LOS, mean (SD), d	4.9 (3.7)	5.0 (3.8)	4.9 (3.7)	4.9 (3.7)	4.8 (3.6)	4.8 (3.6)	4.8 (3.6)	4.8 (3.5)	4.8 (3.5)	4.8 (3.5)	4.9 (3.5)	<.001
All-cause readmission within 30 d of discharge	68 285 (21.2)	69 916 (20.1)	58 356 (20.0)	53 512 (20.3)	51 588 (20.3)	48 912 (20.2)	46 460 (20.0)	41 906 (19.5)	39 171 (18.6)	38 918 (18.6)	35 584 (18.5)	<.001
Total hospital days within 30 d of index admission, mean (SD)	5.9 (4.7)	5.9 (4.7)	5.9 (4.7)	5.9 (4.6)	5.8 (4.6)	5.7 (4.5)	5.7 (4.5)	5.7 (4.5)	5.7 (4.4)	5.7 (4.4)	5.7 (4.4)	<.001
Heart failure readmission within 30 d of discharge	24 387 (7.6)	22 338 (6.4)	17 700 (6.1)	16 006 (6.1)	16 157 (6.4)	15 043 (6.2)	13 978 (6.0)	12 487 (5.8)	11 720 (5.6)	11 778 (5.6)	10 866 (5.7)	<.001
Cardiovascular readmission within 30 d of discharge	29 370 (9.1)	27 808 (8.0)	22 488 (7.7)	20 309 (7.7)	20 317 (8.0)	19 081 (7.9)	17 775 (7.7)	16 100 (7.5)	15 024 (7.1)	15 110 (7.2)	13 825 (7.2)	<.001
Noncardiovascular readmission within 30 d of discharge	13 825 (13.4)	46 332 (13.3)	39 257 (13.5)	36 278 (13.7)	34 323 (13.5)	32 692 (13.5)	31 299 (13.5)	28 199 (13.1)	26 247 (12.5)	25 956 (12.4)	23 623 (12.3)	<.001
Index hospitalization mortality, No./Total No. (%)	13466/335 719 (4.0)	14771/363 400 (4.1)	11909/303 804 (3.9)	10703/274 765 (3.9)	10 269/264 236 (3.9)	9410/251 291 (3.7)	8867/240 730 (3.7)	8116/223 095 (3.6)	7644/218 307 (3.5)	7377/216 655 (3.4)	6669/199 028 (3.4)	<.001

Abbreviation: LOS, length of stay (during index hospitalization); NA, not applicable.

[a] In 2005, discharges from April 1 to December 31 were included; 2015 includes discharges from January 1 to December 1.

[b] Trend *P* values were calculated using the Cochrane-Armitage test (readmissions and mortality), Cochrane-Mantel-Haenszel test with nonzero correlation statistic (length of stay), or linear regression (acute length of stay).

Table 3. Comparison of Postdischarge Outcomes in Subgroups of Patients With Heart Failure in Canada vs the United States From 2005 to 2015

Index Short-term Length of Stay	Age Group, y	Canada			United States		
		Total Patients, No.	All-Cause Readmission, No. (%)	Heart Failure-Specific Readmission, No. (%)	Total Patients, No.	All-Cause Readmission, No. (%)	Heart Failure-Specific Readmission, No. (%)
≤4 d	<65	15 094	2279 (15.1)	890 (5.9)	175 618	35 650 (20.3)	11 591 (6.6)
	65-74	18 543	3022 (16.3)	1261 (6.8)	386 875	64 608 (16.7)	20 504 (5.3)
	75-84	29 870	5316 (17.8)	2180 (7.3)	573 685	99 248 (17.3)	31 553 (5.5)
	≥85	25 204	4612 (18.3)	1941 (7.7)	503 034	88 031 (17.5)	29 679 (5.9)
>4 d	<65	21 740	3457 (15.9)	1239 (5.7)	108 989	27 356 (25.1)	8392 (7.7)
	65-74	28 046	5160 (18.4)	1879 (6.7)	256 212	59 697 (23.3)	17 679 (6.9)
	75-84	51 918	10 176 (19.6)	3894 (7.5)	411 911	96 799 (23.5)	28 422 (6.9)
	≥85	48 616	9480 (19.5)	3743 (7.7)	365 505	81 508 (22.3)	24 854 (6.8)

significantly declined (from 68 285 of 322 253 patients [21.2%] to 35 584 of 192 359 patients [18.5%]; *P* < .001), and HF-specific 30-day readmission rates significantly declined over the decade (from 24 387 of 322 253 patients [7.6%] to 10 866 of 192 359 patients [5.7%]; *P* < .001; Table 2), with the relative magnitude of the reduction similar in both countries (10.7% in Canada vs 12.8% in the United States for all-cause readmissions and 17.9% vs 25.0% for HF-specific readmissions).

Comparisons

The segmented regression analysis comparing 30-day all-cause readmission rates by fiscal quarters of years (Figure) revealed that rates decreased significantly in both countries over the decade (Canada: 2005, 4088 of 20 758 [19.7%]; 2015, 3823 of 21 733 [17.6%]; *P* < .001; United States: 2005, 68 285 of 322 253 [21.2%]; 2015, 35 584 of 192 359 [18.5%]; *P* < .001; Table 2) with no statistically significant changes in either country after October 2012. Neither country exhibited a significant level change in October 2012. In Canada, all-cause readmissions were decreasing 1.1% per year before and 1.3% after October 2012 (*P* = .84 for slope change) compared with 1.6% per year in the United States before and 1.8% per year after October 2012 (*P* = .60 for slope change). The sensitivity analysis comparing all-cause readmission rates before and after April 2010 revealed the same downward trend from 2005 to 2015, with no significant changes in Canada in that quarter. In the United States, there was a statistically significant but small temporary increase in all-cause readmissions (adjusted level change, 1.15 [95% CI, 1.12-1.17]; *P* < .001) around April 2010 that lasted for only 1 quarter of a year (with a 0.8% higher readmission rate in that quarter compared with the quarters before and after). This caused a statistical artifact, in that all-cause readmissions in the United States exhibited a statistically significant slope change after April 2010 and appeared to decrease by 3.6% (95% CI, 3.3%-3.9%; *P* < .001) per year after this point because of the positive level change in April 2010. However, segmented regression analysis across the entire decade revealed that although the acceleration in the rate of decrease in all-cause readmission rates after April 2010 was statistically significant, this change was of small magnitude (adjusted odds ratio, 0.997 [95% CI, 0.997-0.998]).

Comparison of Postdischarge Events in Canada vs the United States

The comparison of postdischarge outcomes within subgroups defined by index hospital LOS and patient age (**Table 3**) revealed that all-cause readmission rates were higher for patients with LOS longer than 4 days compared with those with shorter LOS (28 260 of 150 320 [18.8%] vs 15 258 of 88 711 [17.2%] in Canada; *P* < .001; 265 087 of 1 142 617 [23.2%] vs 286 862 of 1 639 212 [17.5%] in the United States; *P* < .001). This finding was driven primarily by higher noncardiovascular readmissions (16 685 of 150 320 [11.1%] in those with index LOS >4 days vs 8338 of 88 711 [9.4%] in those with index LOS <4 days in Canada, and 181 676 of 1 142 617 [15.9%] vs 186 870 of 1 639 212 [11.4%] in the United States; *P* < .001), because HF-specific readmissions were equal in Canada for those with LOS longer than 4 days vs those with LOS of 4 days or less (10 673 of 150 320 [7.1%] vs 6298 of 88 711 [7.1%]) and only slightly higher in the United States (78 840 of 1 142 617 [6.9%] for LOS >4 days vs 93 435 of 1 639 212 [5.7%] for LOS ≤4 days in the United States; *P* < .001). The crossnational comparison within subgroups defined by age and LOS revealed that HF-specific readmission rates differed little between countries (and in fact were slightly lower in the United States), but noncardiovascular readmissions were consistently higher in the United States (other than in the subgroup younger than 65 years; the only individuals younger than 65 years eligible for Medicare in the United States were those receiving Social Security Disability benefits).

Associations Between LOS and 30-day Readmissions

There were small but statistically significant positive correlations between LOS and 30-day readmissions in both Canada and the United States (**Table 4**). The association was strongest for noncardiovascular readmissions in both countries (adjusted odds ratios: Canada, 1.01 [95% CI, 1.01-1.02]; United States, 1.01 [95% CI, 1.01-1.02]) but was statistically significant for HF-specific readmissions (adjusted odds ratios: Canada, 1.00 [95% CI, 1.00-1.01]; United States, 1.03 [95% CI, 1.03-1.03]) and all-cause readmissions (adjusted odds ratios: Canada, 1.01 [95% CI, 1.008-1.012]; United States, 1.04 [95% CI, 1.04-1.04]) as well.

Table 4. Unadjusted and Adjusted Odds Ratios for Patient-Level Association Between Length of Stay and 30-Day Readmissions

Variable	Length of Stay[a] Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)
Canada[b]		
All-cause readmission	1.01 (1.01-1.02)	1.01 (1.01-1.01)
Heart failure readmission	1.00 (1.00-1.01)	1.00 (1.00-1.01)
Noncardiovascular readmission	1.02 (1.02-1.02)	1.01 (1.01-1.02)
Canada sensitivity analysis[b]		
All-cause readmission	1.01 (1.01-1.01)	1.01 (1.01-1.01)
Heart failure readmission	1.00 (1.00-1.01)	1.003 (1.00-1.01)
Noncardiovascular readmission	1.02 (1.01-1.02)	1.01 (1.01-1.02)
United States[c]		
All-cause readmission	1.05 (1.05-1.05)	1.04 (1.04-1.04)
Heart failure readmission	1.03 (1.03-1.03)	1.03 (1.03-1.03)
Noncardiovascular readmission	1.06 (1.06-1.06)	1.04 (1.04-1.04)
United States sensitivity analysis[c]		
All-cause readmission	1.06 (1.06-1.06)	1.04 (1.04-1.05)
Heart failure readmission	1.03 (1.03-1.04)	1.03 (1.03-1.03)
Noncardiovascular readmission	1.06 (1.06-1.06)	1.04 (1.04-1.05)

[a] Odds ratios are per 1-day increase; adjusted odds ratios were derived using logistic regression model where hospitals are treated as random effects and adjusted for the following variables: age, sex, Charlson comorbidity score, number of hospitalizations in prior 6 months (0, 1, 2, or ≥3), discharge disposition, acuity of index admission, discharge on weekend or holiday, discharge year (discrete variable), rural status, teaching hospital (binary variable), and region (Canadian province or US Northeast, Midwest, West, or South).

[b] The full Canadian cohort includes 239 031 individuals, while the sensitivity analysis of individuals 65 years or older includes 202 197 individuals.

[c] The full US cohort includes 2 781 829 individuals, while the sensitivity analysis of individuals 65 years and older includes 2 497 222 individuals.

Discussion

This comparison of health outcomes for patients admitted for HF revealed that LOS (both for the index hospitalization and for total inpatient days of care in the first 30 days) was longer and in-hospital mortality was higher, but all-cause 30-day readmission rates were lower in Canada than the United States. The subgroup comparisons confirmed that the differences between countries were largely owing to lower noncardiovascular readmissions in Canada, because HF-specific readmission rates were lower in the United States within most subgroups defined by age and LOS. However, given the differences in in-hospital mortality, conclusions cannot be drawn from comparing rates between countries. Rather, the more important finding is that readmission rates declined over the decade studied to a similar extent in both countries, with no significant acceleration in the United States compared with Canada after HRRP implementation in October 2012. While there was a statistically significant acceleration in the rate of decrease in all-cause readmission rates in the United States after April 2010 (when the Patient Protection and Affordable Care Act was passed) that was not seen in Canada, this was small (adjusted odds ratio, 0.997 [95% CI, 0.997-0.998]).

We found a weak positive correlation between LOS and 30-day readmissions in both countries, largely attributable to noncardiovascular readmissions (consistent with the hypothesis that patients with more complex conditions and multiple comorbidities tend to require longer hospitalizations but still have higher postdischarge event rates because of non-HF comorbidities). This is not surprising, because LOS is a marker for patient complexity and can serve as a proxy for many unmeasured confounders. The demonstration of this association should not be confused with causation and should not lead to the conclusion that reducing an individual patient's LOS would necessarily reduce their chance of readmission after discharge.

A number of recent studies have reported that hospital readmissions for HF, myocardial infarction, and pneumonia have decreased since implementation of HRRP payment penalties in the United States.[15-20] However, these were all before-and-after analyses without external controls. Our finding that all-cause readmission rates in the United States have declined to the same extent over the past decade as those in Canada would suggest that the implementation of financial payment penalties in October 2012 under the HRRP may not have had as large an influence as was previously thought. This is perhaps not surprising when one considers the limited effect of pay-for-performance programs previously demonstrated in various health care systems.[21] Regardless, it highlights the continued need for further efforts to improve postdischarge outcomes.

We acknowledge that the Canadian cohort may be less sick than their US counterparts at the time of discharge (given the longer LOS and higher in-hospital mortality rates for HF hospitalizations in Canada). However, because numerous studies have suggested that early outpatient follow-up after discharge improves outcomes, it is interesting to speculate to what extent the lower 30-day noncardiovascular readmission rates in Canada are owing to the higher rates of physician follow-up (and particularly continuity with familiar physicians) in the first 2 weeks after discharge that were documented in Canada[22] compared with US settings.[13,23,24] A wealth of studies[25-27] have already shown that quality-improvement strategies that improve care coordination and/or continuity for patients with chronic conditions do reduce subsequent hospitalizations, and 1 of the key attributes of successful HF disease management programs is health care team familiarity with a patient.[28] Health care professionals who have a long-term clinical relationship with a patient are likely to have a better sense of that patient's unique social factors, which are difficult to quantify and may influence hospitalization risk.[29] Indeed, Medicare beneficiaries who receive transitional care management services (which include following up a patient within 14 days of discharge) do exhibit lower rates of death and readmission and lower health care costs.[30] Despite evidence of their efficacy and a specific Medicare payment code for transitional care management, less than 1 in 14 eligible patients received transitional care management services, even in 2015.[30]

Limitations

Despite reporting outcomes in all adults (ie, not just elderly patients) hospitalized in 9 provinces and 3 territories of

Canada (a country with universal access free health coverage) with a primary diagnosis of HF, and robust data linkage with adjustment for comorbidities and health resource use before the index hospitalization in both countries, there are some limitations to this analysis. First, we relied on administrative data to define HF and comorbidities and do not have information on left ventricular ejection fraction, natriuretic peptide levels, or clinical findings that would delineate severity of illness. While we recognize this weakness, we used validated *ICD* codes and data definition algorithms[11] to build comorbidity profiles, and the outcomes we evaluated (LOS and 30-day readmissions) are relevant in patients with HF regardless of left ventricular ejection fraction, causative mechanism, or clinical status. Second, we did not have data on out-of-hospital deaths, but prior studies in Canada and the United States have reported that less than 1% of patients discharged after a HF hospitalization die out of hospital in the subsequent month, with similar rates between the 2 countries, suggesting that any disparity from differences in this competing risk is likely to be small.[12,13] Regardless, decreases in 30-day readmissions after the implementation of the HRRP appears to have been associated with increases in 30-day mortality in at least 2 studies,[17,20] highlighting an important avenue for further study. Higher in-hospital mortality rates and longer LOS for Canadian patients with HF have been noted before and are likely multifactorial, given different admission thresholds and management practices in both countries, but this is also at least partly explained by the much higher use of hospice care for patients with end-stage HF in the United States than Canada.[31-33] Third, although the Medicare Hospitalization files switched from *ICD-9* coding to *ICD-10* during the years we studied, this only occurred in October 2015 and thus did not affect our interrupted time-series analyses, which evaluated potential inflection points in April 2010 and October 2012. Perusal of the Figure confirms the readmission rates did not change appreciably in the final quarter of 2015.

Conclusions

In conclusion, the similar temporal declines in 30-day all-cause readmission rates in Canada and the United States over the past decade, which show no significant difference after implementation of hospital penalty payments in the United States in October 2012, suggest that any benefits of the HRRP are modest at best. Thus, further efforts beyond public reporting and financial penalties are required to achieve better outcomes for patients with HF who are discharged from the hospital.

ARTICLE INFORMATION

Accepted for Publication: February 1, 2019.

Published Online: April 10, 2019. doi:10.1001/jamacardio.2019.0766

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Author Contributions: Dr McAlister had full access to all of the Canadian data and Dr Samsky had full access to all of the US data in the study, and they both take responsibility for the integrity of the data and the accuracy of the data analysis.
Concept and design: Samsky, Ambrosy, Hernandez, McAlister.
Acquisition, analysis, or interpretation of data: All authors.
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Statistical analysis: Samsky, Youngson, Liang, Kaul.
Administrative, technical, or material support: Samsky, Ambrosy, Peterson.
Supervision: Ambrosy, Peterson, McAlister.

Conflict of Interest Disclosures: Dr Hernandez reported grants and personal fees from AstraZeneca, Luitpold, and Novartis; personal fees from Bayer and Boston Scientific; and grants from Merck and Verily outside the submitted work. Dr Peterson reported grants and personal fees from AstraZeneca, Sanofi Aventis, Janssen, and Merck and grants from Amgen during the conduct of the study. No other disclosures were reported.

Funding/Support: This study was supported by a National Heart, Lung, and Blood Institute T32 postdoctoral training grant (5T32HL069749-14 [Dr Ambrosy]) and the Alberta Health Services Chair in Cardiovascular Outcomes (Dr McAlister).

Role of the Funder/Sponsor: The funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Disclaimer: Dr Hernandez is an associate editor of *JAMA Cardiology*, but he was not involved in any of the decisions regarding review of the manuscript or its acceptance.

Additional Contributions: The authors thank Anne Hellkamp, MSc, and Barbara Lytle, BA, Duke University, for assistance with additional statistical analyses. They were not compensated for their contributions.

REFERENCES

1. Schneider EC, Sarnak DO, Squires D, Doty MM. Mirror, mirror 2017: international comparison reflects flaws and opportunities for better US health care. https://www.commonwealthfund.org/publications/fund-reports/2017/jul/mirror-mirror-2017-international-comparison-reflects-flaws-and. Published July 14, 2017. Accessed February 28, 2019.

2. Heidenreich PA, Albert NM, Allen LA, et al; American Heart Association Advocacy Coordinating Committee; Council on Arteriosclerosis, Thrombosis and Vascular Biology; Council on Cardiovascular Radiology and Intervention; Council on Clinical Cardiology; Council on Epidemiology and Prevention; Stroke Council. Forecasting the impact of heart failure in the United States: a policy statement from the American Heart Association. *Circ Heart Fail*. 2013;6(3):606-619. doi:10.1161/HHF.0b013e318291329a

3. McIlvennan CK, Eapen ZJ, Allen LA. Hospital readmissions reduction program. *Circulation*. 2015; 131(20):1796-1803. doi:10.1161/CIRCULATIONAHA.114.010270

4. Jencks SF, Williams MV, Coleman EA. Rehospitalizations among patients in the Medicare fee-for-service program. *N Engl J Med*. 2009;360 (14):1418-1428. doi:10.1056/NEJMsa0803563

5. Go AS, Mozaffarian D, Roger VL, et al; American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Executive summary: heart disease and stroke statistics—2013 update: a report from the American Heart Association. *Circulation*. 2013;127(1):143-152. doi:10.1161/CIR.0b013e318282ab8f

6. Eapen ZJ, Reed SD, Li Y, et al. Do countries or hospitals with longer hospital stays for acute heart failure have lower readmission rates?: findings from ASCEND-HF. *Circ Heart Fail*. 2013;6(4):727-732. doi:10.1161/CIRCHEARTFAILURE.112.000265

7. Bueno H, Ross JS, Wang Y, et al. Trends in length of stay and short-term outcomes among Medicare patients hospitalized for heart failure, 1993-2006.

JAMA. 2010;303(21):2141-2147. doi:10.1001/jama.2010.748

8. Baker DW, Einstadter D, Husak SS, Cebul RD. Trends in postdischarge mortality and readmissions: has length of stay declined too far? *Arch Intern Med*. 2004;164(5):538-544. doi:10.1001/archinte.164.5.538

9. Kaboli PJ, Go JT, Hockenberry J, et al. Associations between reduced hospital length of stay and 30-day readmission rate and mortality: 14-year experience in 129 Veterans Affairs hospitals. *Ann Intern Med*. 2012;157(12):837-845. doi:10.7326/0003-4819-157-12-201212180-00003

10. Khan H, Greene SJ, Fonarow GC, et al; EVEREST Trial Investigators. Length of hospital stay and 30-day readmission following heart failure hospitalization: insights from the EVEREST trial. *Eur J Heart Fail*. 2015;17(10):1022-1031. doi:10.1002/ejhf.282

11. Quan H, Li B, Saunders LD, et al; IMECCHI Investigators. Assessing validity of *ICD-9-CM* and *ICD-10* administrative data in recording clinical conditions in a unique dually coded database. *Health Serv Res*. 2008;43(4):1424-1441. doi:10.1111/j.1475-6773.2007.00822.x

12. McAlister FA, Au AG, Majumdar SR, Youngson E, Padwal RS. Postdischarge outcomes in heart failure are better for teaching hospitals and weekday discharges. *Circ Heart Fail*. 2013;6(5):922-929. doi:10.1161/CIRCHEARTFAILURE.113.000336

13. Shen E, Koyama SY, Huynh DN, et al. Association of a dedicated post-hospital discharge follow-up visit and 30-day readmission risk in a medicare advantage population. *JAMA Intern Med*. 2017;177(1):132-135. doi:10.1001/jamainternmed.2016.7061

14. Keenan PS, Normand SL, Lin Z, et al. An administrative claims measure suitable for profiling hospital performance on the basis of 30-day all-cause readmission rates among patients with heart failure. *Circ Cardiovasc Qual Outcomes*. 2008;1(1):29-37. doi:10.1161/CIRCOUTCOMES.108.802686

15. Desai NR, Ross JS, Kwon JY, et al. Association Between hospital penalty status under the hospital readmission reduction program and readmission rates for target and nontarget conditions. *JAMA*. 2016;316(24):2647-2656. doi:10.1001/jama.2016.18533

16. Zuckerman RB, Sheingold SH, Orav EJ, Ruhter J, Epstein AM. Readmissions, observation, and the Hospital Readmissions Reduction Program. *N Engl J Med*. 2016;374(16):1543-1551. doi:10.1056/NEJMsa1513024

17. Gupta A, Allen LA, Bhatt DL, et al. Association of the hospital readmissions reduction program implementation with readmission and mortality outcomes in heart failure. *JAMA Cardiol*. 2018;3(1):44-53. doi:10.1001/jamacardio.2017.4265

18. Dharmarajan K, Wang Y, Lin Z, et al. Association of changing hospital readmission rates with mortality rates after hospital discharge. *JAMA*. 2017;318(3):270-278. doi:10.1001/jama.2017.8444

19. Wasfy JH, Zigler CM, Choirat C, Wang Y, Dominici F, Yeh RW. Readmission rates after passage of the Hospital Readmissions Reduction Program: a pre-post analysis. *Ann Intern Med*. 2017;166(5):324-331. doi:10.7326/M16-0185

20. Abdul-Aziz AA, Hayward RA, Aaronson KD, Hummel SL. Association between Medicare Hospital Readmission Penalties and 30-day combined excess readmission and mortality. *JAMA Cardiol*. 2017;2(2):200-203. doi:10.1001/jamacardio.2016.3704

21. Houle SK, McAlister FA, Jackevicius CA, Chuck AW, Tsuyuki RT. Does performance-based remuneration for individual health care practitioners affect patient care?: a systematic review. *Ann Intern Med*. 2012;157(12):889-899. doi:10.7326/0003-4819-157-12-201212180-00009

22. McAlister FA, Youngson E, Bakal JA, Kaul P, Ezekowitz J, van Walraven C. Impact of physician continuity on death or urgent readmission after discharge among patients with heart failure. *CMAJ*. 2013;185(14):E681-E689. doi:10.1503/cmaj.130048

23. Hernandez AF, Greiner MA, Fonarow GC, et al. Relationship between early physician follow-up and 30-day readmission among Medicare beneficiaries hospitalized for heart failure. *JAMA*. 2010;303(17):1716-1722. doi:10.1001/jama.2010.533

24. DeVore AD, Cox M, Eapen ZJ, et al. Temporal trends and variation in early scheduled follow-up after a hospitalization for heart failure: findings from Get With The Guidelines-Heart Failure. *Circ Heart Fail*. 2016;9(1):e002344. doi:10.1161/CIRCHEARTFAILURE.115.002344

25. Tricco AC, Antony J, Ivers NM, et al. Effectiveness of quality improvement strategies for coordination of care to reduce use of health care services: a systematic review and meta-analysis. *CMAJ*. 2014;186(15):E568-E578. doi:10.1503/cmaj.140289

26. van Walraven C, Oake N, Jennings A, Forster AJ. The association between continuity of care and outcomes: a systematic and critical review. *J Eval Clin Pract*. 2010;16(5):947-956. doi:10.1111/j.1365-2753.2009.01235.x

27. Nuckols TK, Keeler E, Morton S, et al. Economic evaluation of quality improvement interventions designed to prevent hospital readmission: a systematic review and meta-analysis. *JAMA Intern Med*. 2017;177(7):975-985. doi:10.1001/jamainternmed.2017.1136

28. Sochalski J, Jaarsma T, Krumholz HM, et al. What works in chronic care management: the case of heart failure. *Health Aff (Millwood)*. 2009;28(1):179-189. doi:10.1377/hlthaff.28.1.179

29. Singh S, Lin YL, Kuo YF, Nattinger AB, Goodwin JS. Variation in the risk of readmission among hospitals: the relative contribution of patient, hospital and inpatient provider characteristics. *J Gen Intern Med*. 2014;29(4):572-578. doi:10.1007/s11606-013-2723-7

30. Bindman AB, Cox DF. Changes in health care costs and mortality associated with transitional care management services after a discharge among Medicare beneficiaries. *JAMA Intern Med*. 2018;178(9):1165-1171. doi:10.1001/jamainternmed.2018.2572

31. Unroe KT, Greiner MA, Hernandez AF, et al. Resource use in the last 6 months of life among medicare beneficiaries with heart failure, 2000-2007. *Arch Intern Med*. 2011;171(3):196-203. doi:10.1001/archinternmed.2010.371

32. Kaul P, Reed SD, Hernandez AF, et al. Differences in treatment, outcomes, and quality of life among patients with heart failure in Canada and the United States. *JACC Heart Fail*. 2013;1(6):523-530. doi:10.1016/j.jchf.2013.07.004

33. Kaul P, McAlister FA, Ezekowitz JA, et al. Resource use in the last 6 months of life among patients with heart failure in Canada. *Arch Intern Med*. 2011;171(3):211-217. doi:10.1001/archinternmed.2010.365