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Research

Health expenditures after first hospital admission for heart failure in Nova Scotia, Canada: a retrospective cohort study

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Abstract

Background: Although the frequency of heart failure makes it among the costliest of illnesses, there are scant Canadian data on annual costs of treatment or the costs as the condition advances. Our objective was to estimate mean prevalence- and incidence-based direct medical costs among older adults discharged alive after a first hospital admission for heart failure.

Methods: We conducted a retrospective cohort study using population-based administrative health databases for Nova Scotia. The cohort comprised persons 50 years of age or older with an incident hospital admission for heart failure between 2009 and 2012. We considered the costs (expressed as 2020 Canadian dollars) of hospital admissions, physician visits and, for patients 65 years of age or older, outpatient cardiac medications. We estimated costs for calendar years, longitudinally and in the last 2 years of life. We analyzed costs from the perspective of a third-party public payer.

Results: The cohort consisted of 3327 patients (mean age 77.6 yr; 1605 [48.2%] women). Median survival was 2.5 and 2.2 years among men and women, respectively. Annual prevalence-based costs were about $7100. Mean incidence-based costs ranged between $65 000 and $164 000 in the year after diagnosis and decreased by 90% subsequently. Costs were 4 to 7 times higher in the year before death than in the period from 1 to 2 years before death.

Interpretation: The direct medical costs of treating patients with heart failure in Nova Scotia displayed a reverse J shape, with costs highest after diagnosis, declining subsequently and then increasing during the final year of life. Strategies designed to improve the quality of care immediately after diagnosis and during more advanced stages of disease might reduce these costs.

Treating people with heart failure imposes enormous economic burdens on all developed countries, accounting for between 1% and 2%,[1,2] and possibly as high as 3.2%,[3] of total annual direct medical costs. These costs arise because heart failure is common, its incidence increases rapidly after middle age, and its management requires high-intensity care, including regular hospital admissions. According to the Canadian Institute for Health Information (CIHI), heart failure is the third most common reason for hospital admission in Canada,[4] has the highest rates of readmission[5] and is the second most costly cause of admission.[6] As such, it is considered an important driver of health care resource utilization in Canadian health care systems.[7,8]

Despite these figures, there exists scant reliable information on resource use and costs on which to base strategies and policies for managing the care of Canadians with a diagnosis of heart failure. For example, a systematic review of cost-of-illness studies published between 2004 and 2016 yielded no Canadian studies on the topic,[9] and another on studies published between 2003 and 2015[10] yielded only 1 Canadian study, which examined costs in the first year after discharge.[11]

Studies from other jurisdictions can provide benchmarks and knowledge applicable to Canada, although mean annual costs vary substantially by jurisdiction.[12,13] Investigators have shown that the largest component of direct medical costs — more than 50% — relates to hospital admission, followed by medications;[9] that newly diagnosed patients have higher costs than those later in the course of disease; and that direct medical costs increase during the final months of life.[14–16]

Competing interests: Adrian Levy has served as a paid consultant to Broadstreet Health Economics & Outcomes Research and Novartis Pharmaceuticals Canada Inc. Karissa Johnston and Basia Rogula have served as paid consultants to Novartis Pharmaceuticals Canada Inc. Alexia Daoust and Jonathan Fortier are employees and shareholders of Novartis Pharmaceuticals Canada Inc. Paul Oh has participated on advisory boards funded by Amgen, Astra Zeneca and Novartis. No other competing interests were declared.

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Reliable estimates of the direct medical costs of heart failure are required for important evaluative and research purposes. The costs of illness can be useful for various reasons: identifying differences in the distribution of costs among demographic groups or jurisdictions, which can be used to generate hypotheses about reducing costs; highlighting areas where practice variations occur; and identifying potentially inefficient uses of resources. These hypotheses can, in turn, help determine research and funding priorities.[17,18] Cost-of-illness studies are also needed to quantify changes that may arise through new management approaches or public policies.[17] From a public health perspective, the distribution of costs can be used to identify potential areas of inequitable allocation of resources.[18] It can also provide reliable inputs for cost-effectiveness models, which otherwise may be based on costs collected during randomized trials (which may not reflect actual practice).

Two approaches to the costing of illness exist: incidence-based and prevalence-based. The incidence-based approach involves calculating the costs of treatment for typical individuals from diagnosis until death (or resolution), whereas the prevalence-based approach estimates the total cost to a population living with the disease incurred in a given calendar year.[17] To our knowledge, there are no published Canadian estimates using either approach for heart failure. Our objective was to estimate, among residents of Nova Scotia, Canada, aged 50 years or older who were discharged alive after a first hospital admission for heart failure, the mean overall prevalence-based (2013–2015) and incidence-based (2009–2015) direct medical costs. We also report direct medical costs in the 2 years before death.

Methods

Study design and participants

We conducted a retrospective, population-based cohort study using Nova Scotia administrative health databases for hospital discharge abstracts, physician billing claims, prescription claims for persons aged 65 years or older, and death certificates. These data, which were linked using encrypted identifiers,[19] included records for medical and hospital services for all provincial health plan registrants in Nova Scotia (more than 98% of the province's 923 598 residents, of whom 183 820 were 65 yr of age or older) in 2016.

The study population consisted of all registered Nova Scotians aged 50 years or older who had a "most responsible diagnosis" code of heart failure (*International Statistical Classification of Diseases and Related Health Problems* [ICD], *10th Revision* code 150.x) between 2009 and 2012, after removal of anyone with a hospital discharge abstract that included any heart failure coded in 2007 or 2008.

Although there has been little assessment of the reliability of coding of these databases in Nova Scotia,[20] studies in other Canadian provinces have indicated that the algorithm we used generally yields higher specificity and lower sensitivity, indicating high confidence that the individuals in the sample were likely to have suffered acute decompensated heart failure[21] while excluding some suitable patients.[22,23] There is no a priori reason to think that patients whose heart failure was coded with a different discharge diagnosis were systematically different from those included in the analysis.

Given that a diagnosis of heart failure in patients younger than 50 years is rare and often of nonischemic origin (and thus may have different resource implications[24]), we included only individuals 50 years of age or older at the time of the first hospital episode for heart failure. We calculated incidence rates per 100 000 using age- and sex-specific population denominators.[25] We calculated duration of survival using the date of the index admission and the date of death on the death certificate. We illustrated all-cause mortality using Kaplan–Meier curves.

Resource use and costs

We performed the costing analysis from the perspective of a third-party public payer (i.e., the Nova Scotia Department of Health and Wellness) using a bottom–up ("person-based"), rather than a top–down ("population-based"), approach.[26] Medical resources included hospital admissions, physician visits and, for persons aged 65 years or older, cardiac medications. We stratified the costs by sex and age (50 to < 65, 65–80 and > 80 yr) on the admission date for the index admission. We attributed costs to the year of follow-up after hospital discharge, with patients censored on the date of death, end of enrolment or Mar. 31, 2016.

To facilitate future disaggregated comparisons with other jurisdictions, we did not use resource-intensity weights[27] but instead estimated mean annual costs of a hospital stay by multiplying the mean length of stay by a per-diem cost. We tabulated the per-diem costs of hospital stays separately for medical wards and intensive care or coronary care units on the basis of Canadian means from CIHI,[28] inflated to 2020 using the consumer price index,[29] which yielded values of $1139 for a day on a general ward and $3976 for a day in the intensive care unit. We attributed hospital costs to the year in which the admission date fell. We obtained physician fees for all visits to family physicians, cardiologists and cardiac surgeons from the Nova Scotia physician fee schedule.[30]

We included the costs of outpatient medications only for those older than 65 years because this is the age at which the costs are reimbursed by Nova Scotia Pharmacare, and this is therefore the group for whom electronic dispensation claims were available. Medications administered in hospital were included in hospital budgets and could not be isolated. We based the costs of cardiovascular medications on the World Health Organization's Anatomical Therapeutic Chemical classification system for drugs, adapted from the Nova Scotia Pharmacare Drug Formulary[31] (Appendix 1, available at www.cmajopen.ca/content/9/3/E826/suppl/DC1). We multiplied daily medication costs by the number of days supplied to obtain the cost of the dispensation; we excluded dispensing fees.

Statistical analysis

Following conventional principles of cost-of-illness analysis,[32] we estimated both incidence- and prevalence-based costs of heart failure in Nova Scotia. These analyses differ from

cost-effectiveness studies in that they do not include an intervention, comparator groups or clinical outcomes.

For incidence-based costs, we began with the initial admission for heart failure and longitudinally tabulated costs for up to 7 years (2009 to 2015) after diagnosis. For this analysis, we excluded patients with a hospital admission for heart failure in 2007 or 2008.

For prevalence-based costs, we began tabulation with the initial admission for heart failure (including patients who died) and calculated the annual mean for the 3 most recent years available (2013 to 2015). We tabulated the costs in the first and second years before death, accounting for left-censoring for those who survived less than 2 years. For example, those who died on day 365 of follow-up contributed data only to the first year and last year of life categories. Rather than medians, we report mean (and standard deviation [SD]) values because they provide more accurate estimates of total budgets and are thus more useful for policy-making.[32,33] We report all costs in 2020 Canadian dollars.

Ethics approval

This study was approved by the Dalhousie University Health Sciences Research Ethics Board (2016-3979).

Results

A total of 3327 persons aged 50 years and older were discharged from hospital with the most responsible diagnosis code for heart failure between 2009 and 2012. The mean age was 77.6 years, and 1605 (48.2%) were women. Incidence rates increased by an order of magnitude in each age stratum, were higher among men than women in all 3 age strata, and declined in both sexes and all age strata over the period 2009 to 2012 (Table 1).

All-cause mortality after a diagnosis of heart failure was high, with 20% of individuals dying within 2 months and a median survival of 2.5 years for men and 2.2 years for women after the first hospital discharge for heart failure (Figure 1). Survival over 7 years was slightly higher among men than women. About 20% of individuals were alive 7 years after the initial diagnosis.

The mean total annual length of stay for entire hospital admissions (general ward plus intensive care unit) was 4.6 days among both men (SD 13.4 d) and women (SD 13.8 d). The large SD relative to the mean indicates a distribution with a long tail. Among both men and women, the annual length of stay declined with increasing age.

Prevalence-based costs

Between 2013 and 2015, the mean annual prevalence-based costs for all patients was about $7100 for both men and women, assuming the cost of medications is the same in the 50- to 64-year-old group as the older ages (Table 2). The overall cost distribution across resource categories was about 86% for hospital admissions, 10% for medications and 4% for physician services. Mean annual prevalence-based costs declined with age for both men and women. In addition, these costs were higher for women than for men in each age stratum; however, because of different distributions of age, the weighted means of both sexes were similar. Among men, the dispersion (SDs) of annual costs were similar across individual age groups and all ages pooled. Among women, the dispersion of annual costs was highest in the youngest group, indicating that some younger women had a greater number of days in hospital and higher costs.

Incidence-based costs

Mean incidence-based costs were highest in the first year after hospital admission for heart failure, ranging from about $65 000 for men aged 50 to 64 years to $164 000 for men older than 80 years and from about $93 000 for women aged 50 to 64 years to almost $144 000 for women older than 80 years (Table 3). For those who survived until the second year after discharge, incidence-based costs decreased by about 83% in the second year and continued to decline more slowly over time, such that by 7 years after the initial admission for heart failure, costs (over all age groups) were 92% lower than in the first year. Given the median survival of 2.2 years for women and 2.5 years for men (Figure 1), the relatively few patients surviving beyond 3 years showed increased dispersion (i.e., SD) of the mean costs.

Direct medical costs

Compared with the period from 1 to 2 years before death, direct medical costs were between 4 and 7 times higher in the

Table 1: Rates of first hospital discharge for heart failure* among Nova Scotia residents 50 years or older, 2009 to 2012

	Sex; age group, yr; rate per 100 000 (count, *n*)								
	Men				Women				
Year	50–64	65–80	> 80	All men ≥ 50	50–64	65–80	> 80	All women ≥ 50	All patients
2009	83 (84)	414 (216)	1505 (178)	289 (478)	44 (46)	292 (173)	925 (213)	230 (432)	258 (910)
2010	91 (94)	368 (198)	1159 (141)	256 (433)	39 (42)	221 (134)	987 (229)	211 (405)	232 (838)
2011	81 (85)	322 (180)	1307 (161)	246 (426)	35 (39)	226 (141)	991 (231)	210 (411)	227 (837)
2012	67 (71)	294 (173)	1109 (141)	217 (385)	30 (33)	213 (139)	779 (185)	178 (357)	196 (742)

*Based on *International Statistical Classification of Diseases and Related Health Problems, 10th Revision*, code 150.x.

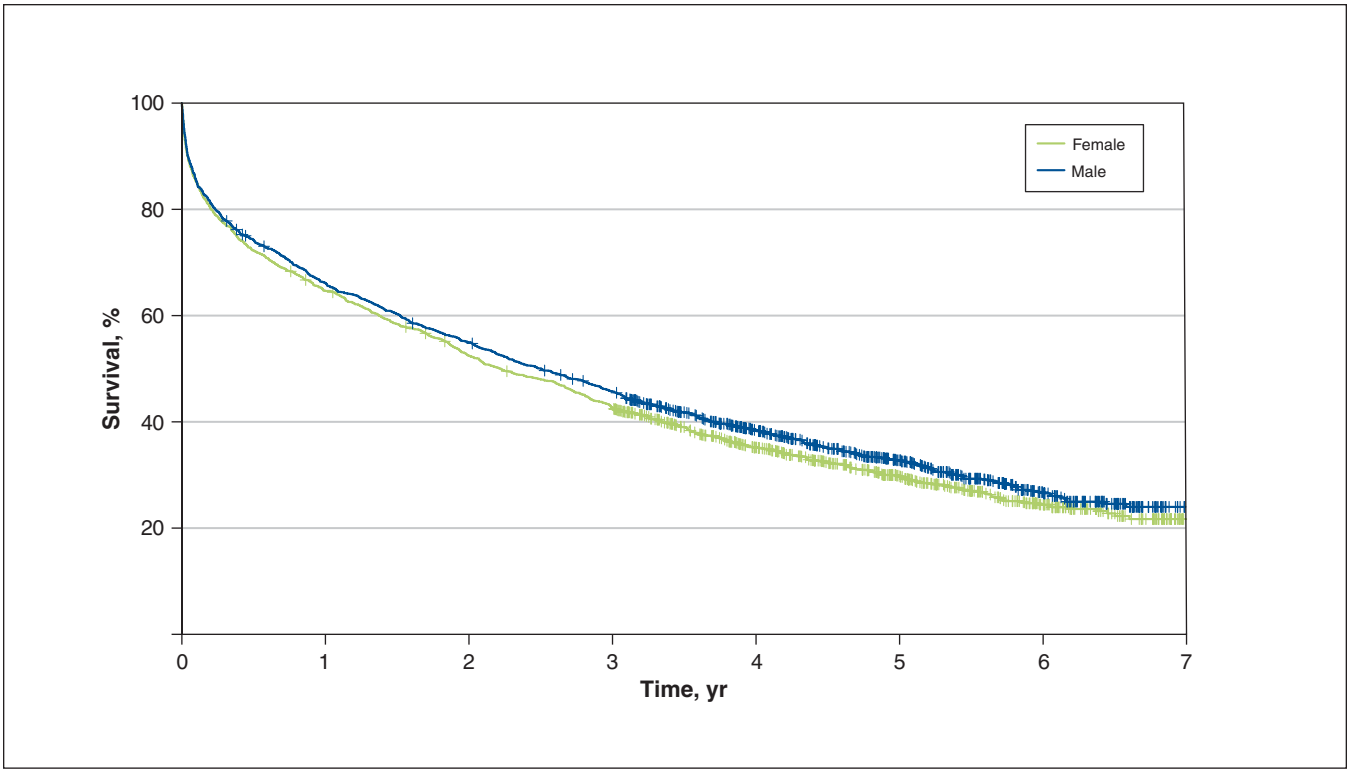

Figure 1: Kaplan–Meier curve for death from any cause after first hospital admission for heart failure among Nova Scotia residents aged 50 years or older, by sex, 2009 to 2012.

year before death (Table 4). The costs in the year before death were still substantially lower than in the first year after diagnosis (Table 3).

Interpretation

For patients admitted to hospital for heart failure in Nova Scotia, costs were highest in the first year after admission, then decreased to a relatively stable lower level and increased again toward the end of life. The initial pattern is similar to curves reported from other jurisdictions,[34] and the increased costs in the last year of life are consistent with a previous Canadian study.[16] Selection of patients according to the most responsible diagnosis led to an estimate of mean annual prevalence-based costs in Nova Scotia of about $7100. Hospital admissions formed the biggest cost driver, being about 6 times greater than the costs of medication and physician visits combined ($6055 v. $728 + $292). This approach likely depicts a conservative estimate, termed "heart failure in isolation,"[3] and can appropriately represent the lower bound of the costs of illness. Including the costs of conditions that are comorbid with heart failure, such as hypertension, coronary artery disease, renal insufficiency, diabetes mellitus, chronic obstructive pulmonary disease[35] or other conditions,[2] collectively termed "heart failure syndrome," can appropriately represent the upper bound of the costs of illness.

One important audience for this study is Canadian public payers (i.e., hospitals and ministries of health), provided the results are applicable to their jurisdictions. The mean length of stay that we have reported for Nova Scotia (4.6 [SD 13.6] d) was lower than that reported from other Canadian provinces[36] and in the US Medicare hospitalization files (mean 4.9 [SD 3.5] d).[37] Some of this difference may be due to differences in study designs. Those previous authors calculated the mean cost of individual hospital episodes; in contrast, for our prevalence-based estimates from Nova Scotia, we calculated the mean annual total number of hospital days between 2013 and 2015. As such, the methods employed here reflect the perspective of Canadian public payers, not that of patients. These results from Nova Scotia may be generalizable to publicly funded health care systems that are not centrally organized.

Mean prevalence-based costs declined with advancing age among both men and women, with the youngest age group being the costliest (even without including outpatient medications; Table 2). In contrast, mean incidence-based costs showed the opposite pattern, with increasing costs for older groups in most years of follow-up (Table 3). This finding arises from the different designs and interpretations of the analyses: prevalence-based cost-of-illness studies include a cross-section of individuals and therefore reflect an amalgam of costs at various stages of heart failure,[38] whereas incidence-based designs show how costs vary in each age group.

Comparing the mean annual cost of about $7100 with estimates from other countries is fraught with conceptual and methodologic challenges,[9] including the selection of patients (focus on heart failure in isolation v. heart failure syndrome),

Table 2: Annual prevalence-based direct medical costs after first hospital admission for heart failure among Nova Scotia residents 50 years or older, 2013 to 2015, by category of expenditure

	Category of expenditure; length of stay or cost, mean ± SD										
	General ward		ICU		General ward + ICU		Physician visits*		Outpatient cardiovascular medications†		
Age group, yr	Length of stay, d	Cost,‡ $	Length of stay, d	Cost,‡ $	Length of stay, d	Cost,‡ $	No. of visits	Cost, $	No. of dispensations	Cost, $	Total cost,§ $
Men											
50–64	4.9 ± 12.1	5534 ± 13 773	0.6 ± 2.0	2221 ± 7875	5.4 ± 12.8	7754 ± 17 635	17.1 ± 24.3	447 ± 792	NA	NA	8201 ± 17 978
65–80	5.0 ± 13.7	5663 ± 15 615	0.3 ± 1.4	1245 ± 5444	5.3 ± 14.0	6908 ± 17 430	14.1 ± 26.0	365 ± 808	26.4 ± 43.4	856 ± 1009	8129 ± 17 906
> 80	3.2 ± 12.8	3610 ± 14 536	0.1 ± 0.9	494 ± 3701	3.3 ± 13.0	4104 ± 15 776	8.7 ± 19.7	193 ± 521	13.3 ± 33.6	422 ± 807	4719 ± 16 172
All men ≥ 50	4.3 ± 13.1	4897 ± 14 909	0.3 ± 1.4	1163 ± 5523	4.6 ± 13.4	6061 ± 16 950	12.7 ± 23.8	319 ± 721	20.5 ± 39.8	662 ± 949	6380 ± 17 346
Women											
50–64	6.0 ± 14.6	6820 ± 16 575	1.0 ± 8.0	3995 ± 31 960	7.0 ± 17.3	10 815 ± 37 383	16.5 ± 25.7	416 ± 812	NA	NA	11 231 ± 37 871
65–80	5.7 ± 14.8	6457 ± 16 823	0.2 ± 1.1	953 ± 4324	5.9 ± 15.1	7410 ± 18 317	14.8 ± 23.2	347 ± 679	34.4 ± 52.7	956 ± 1353	8712 ± 18 815
> 80	3.1 ± 11.1	3501 ± 12 627	0.2 ± 2.0	728 ± 7993	3.3 ± 11.9	4228 ± 17 135	8.2 ± 18.8	175 ± 461	20.3 ± 39.3	678 ± 767	5082 ± 17 514
All women ≥ 50	4.3 ± 13.0	4913 ± 14 769	0.3 ± 3.0	1136 ± 11 964	4.6 ± 13.8	6048 ± 20 559	11.4 ± 21.6	262 ± 597	26.0 ± 45.7	791 ± 1053	6311 ± 20 922
All patients	4.3 ± 13.0	4905 ± 14 839	0.3 ± 2.3	1150 ± 9209	4.6 ± 13.6	6055 ± 18 775	12.1 ± 22.7	292 ± 664	23.3 ± 43.0	728 ± 1005	6346 ± 19 152

Note: ICU = intensive care unit, NA = not applicable, SD = standard deviation.
*Includes all outpatient visits.
†Anatomical Therapeutic Chemical classification codes for cardiovascular medications: C09AA, C09B, C09CA, C09D, C02, C07, C08, C01DA, C10, C03, C03DA.
‡Per-diem costs were $1139 for the general ward and $3976 for the ICU.
§Includes only costs of hospital admissions and physician visits for rows that include individuals under 65 years of age and additionally includes cardiovascular medications only for rows including individuals aged 65 years and older.

choice of ICD codes, top-down versus bottom-up costing (and, if the latter, the categories included) and perspective of the analysis (e.g., payer or societal). Given these caveats, investigators have shown that the annual cost-of-illness ranges from $868 in South Korea (for 2014; in 2014 US dollars),[12] through $20 245[3] (in 2012 US dollars) and $20 618[34] (in 2008 US dollars) in the United States, to $25 532 in Germany (for 2002; in 2014 US dollars).[13]

At least 2 findings related to the epidemiology of heart failure in Nova Scotia bear greater scrutiny. The prevalence, incidence and mortality in Nova Scotia were similar to those of other Canadian provinces (using the same algorithm, based on most responsible diagnosis, as was used here).[23] The declining rates of hospital discharge for heart failure between 2009 and 2012 are consistent with declining incidence observed in Ontario,[39] the United Kingdom[40] and the US.[41] Using the same algorithm to select patients as was used here, Tran and colleagues[36] projected that hospital costs in Canada would increase from $482 million (95% confidence interval [CI] $464 million to $500 million) in 2013 to $722 million (95% CI $650 million to $801 million) in 2030 (costs standardized to 2014 Canadian dollars). If the incidence is declining, these estimates may shift downward. In addition, survival in Nova Scotia may be lower than has been reported in the literature.[42]

The authors of *The Need for Heart Failure Advocacy in Canada* highlighted limited awareness of the "[heart failure] epidemic, the natural history of the disease, and the potential benefits of available therapies."[7] They called for action from all stakeholders "outlining key targets for health care system redesign and policy initiatives that must be championed to affect [sic] meaningful change toward an optimal future for this disease state."[7] As is the case elsewhere,[9] hospital admissions accounted for the biggest component of costs in Nova Scotia. The finding of increased costs in the first year is also consistent with findings from other jurisdictions. Taken together, interventions and policies designed to reduce hospital admissions early in the course of the disease can serve as targets for evaluation, including improved medication adherence,[43] pre-symptom identification,[44] telemedicine,[45] improved care coordination,[46] transfer to alternate levels of care,[47] clinical pathways[48] or others[49] designed to avoid acute exacerbations and lengthy hospital stays among patients with heart failure. Patients with more advanced disease may benefit from increased emphasis on palliative care services.[50]

Table 3: Incidence-based direct medical costs, categorized by year after first hospital admission for heart failure, among Nova Scotia residents 50 years or older, 2009 to 2015

	Year after diagnosis; incidence-based direct medical costs, $, mean ± SD						
Age group, yr	1	2	3	4	5	6	7
Men							
50–64*	64 640 ± 152 870	17 105 ± 48 073	18 221 ± 57 432	16 450 ± 50 349	17 792 ± 81 437	13 408 ± 50 829	7762 ± 26 896
65–80†	110 001 ± 206 497	23 426 ± 68 003	25 262 ± 59 062	18 812 ± 49 022	18 645 ± 54 732	15 992 ± 63 582	5216 ± 10 895
> 80†	164 076 ± 222 214	23 066 ± 49 634	28 430 ± 66 698	17 269 ± 46 490	9582 ± 18 202	22 842 ± 49 901	20 967 ± 41 126
All men*	120 159 ± 206 602	21 184 ± 58 712	23 535 ± 60 563	17 353 ± 48 895	16 334 ± 61 209	15 860 ± 56 946	9249 ± 26 440
Women							
50–64*	93 240 ± 207 830	26 074 ± 90 889	13 837 ± 27 050	23 486 ± 58 704	12 135 ± 36 964	16 952 ± 41 600	1519 ± 3819
65–80†	107 055 ± 197 685	20 997 ± 48 852	20 007 ± 49 984	18 421 ± 46 767	16 693 ± 53 260	13 723 ± 36 519	14 811 ± 42 874
> 80†	143 821 ± 185 502	22 553 ± 50 256	19 187 ± 49 829	15 155 ± 40 477	10 015 ± 37 370	11 077 ± 30 187	13 083 ± 38 192
All women*	124 606 ± 193 472	21 629 ± 56 439	18 177 ± 47 373	17 405 ± 46 600	13 043 ± 45 626	13 040 ± 35 584	11 474 ± 37 614
All patients*	122 304 ± 200 358	21 396 ± 57 627	21 019 ± 54 818	17 377 ± 47 823	14 812 ± 54 556	14 575 ± 48 377	10 289 ± 32 093

Note: SD = standard deviation.
*Includes costs of hospital admission and physician visits only.
†Includes costs of hospital admission, physician visits and outpatient cardiovascular medications.

Table 4: Costs in the 2 years before death from heart failure, by age and sex, for Nova Scotia residents 50 years of age or older

	1–365 d before death		366–730 d before death	
Age group, yr	*n*	Cost, $, mean ± SD	*n*	Cost, $, mean ± SD
Men				
50–64*	< 5	26 681 ± 20 056	< 5	7409 ± 14 263
65–80†	36	62 623 ± 123 491	36	9185 ± 22 632
> 80†	55	40 921 ± 47 527	54	6071 ± 21 865
All men*	95	48 280 ± 84 321	94	7110 ± 21 655
Women				
50–64*	0	NA	0	NA
65–80†	17	47 427 ± 49 952	17	12 530 ± 43 522
> 80†	62	35 512 ± 47 428	62	9634 ± 26 107
All women*	79	37 819 ± 47 859	79	10 080 ± 30 334
All patients*	174	43 531 ± 70 165	173	8466 ± 25 943

Note: NA = not available, SD = standard deviation.
*Includes costs of hospital admission and physician visits only.
†Includes costs of hospital admission, physician visits and outpatient cardiovascular medications.

Limitations

This study had some important limitations. In particular, follow-up commenced after each patient's first hospital admission, which meant that costs attributable to heart failure before this event were excluded and thus the actual costs of illness may have been underestimated. In this regard, one key

piece of information typically absent from administrative health data is the severity of illness, which for heart failure is often measured using the New York Heart Association (NYHA) 4-level categorization.[51] The first hospital admission for heart failure corresponds roughly to NYHA class III, when disease severity increases and patients become more susceptible to breathlessness requiring admission. In Poland, costs for patients with NYHA class I or II heart failure were between two-thirds and three-quarters of the costs for those with NYHA class III heart failure.[52] Given the potentially larger number of individuals with less severe disease, the total costs could be substantial.

One advantage of the algorithm used in this study was its correspondence with that used by other Canadian investigators.[11,23] However, the exclusion of costs for patients who died during the index admission would lead to underestimation of prevalence- and incidence-based costs.

One challenge with bottom-up costing studies is external validity.[14] By using disaggregated values for length of stay and per-diem costs, future investigators can compare the values they observe with those reported here for Nova Scotia. However, given the similarity among Canadian provinces and territories in terms of organization of care, use of common national clinical practice guidelines, similar financing mechanisms and availability of administrative health data, there are fewer concerns that results will not be applicable to other Canadian jurisdictions.

We did not include any information on emergency department or other outpatient clinic costs or the costs of home services, such as oxygen, cardiac rehabilitation or palliative care, because the database where these resources are curated (the National Ambulatory Care Reporting System) is incomplete for Nova Scotia.

Because the perspective of this study was that of a provincial health payer, we excluded the costs for informal caregivers and lost productivity. One study showed these costs to be greater than the direct medical costs of heart failure.[53] A similar phenomenon may exist in Nova Scotia, whereby a deterioration of health care facilities may increase the burden on home care.[54]

Given the complexity of costing medications for heart failure,[40] we simplified the attribution of costs by including Anatomical Therapeutic Chemical codes for cardiovascular medications only. Similarly, for physician visits, we attributed to heart failure all billings from family physicians, cardiologists, general internists and cardiac surgeons. Although both of these assumptions led to misclassification, the direction of their combined effect on the direct medical costs of illness is unclear.

The costs of outpatient medications were assumed to be the same for patients aged 50 to 64 years as for older patients. In addition, the costs of medications administered in hospital were not isolated but rather were included in the in-hospital per diems.

Conclusion

Direct medical costs of treating patients with heart failure in Nova Scotia displayed a reverse J shape, with highest costs in the first year, a decline over subsequent years and an increase during the final year of life. Strategies designed to improve the quality of care immediately after diagnosis and at more severe stages of disease may reduce hospital episodes and costs.

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