



Original Article

The Current and Future Hospitalization Cost Burden of Syncope in Canada

Dat T. Tran, PhD,^{a,b,c} Robert S. Sheldon, MD, PhD,^d Padma Kaul, PhD,^{c,e} and
Roopinder K. Sandhu, MD, MPH^{c,e}

^a Institute of Health Economics, Edmonton, Alberta, Canada

^b Faculty of Pharmacy and Pharmaceutical Sciences, University of Alberta, Edmonton, Alberta, Canada

^c Canadian VIGOUR Centre, University of Alberta, Edmonton, Alberta, Canada

^d Division of Cardiology, University of Calgary, Calgary, Alberta, Canada

^e Division of Cardiology, Faculty of Medicine and Dentistry, University of Alberta, Edmonton, Alberta, Canada

ABSTRACT

Background: Single-center studies have shown the high costs associated with the hospital evaluation of syncope. National cost estimates for syncope-related hospitalizations are sparse, and none exist in Canada.

Methods: The Canadian Institute for Health Information Discharge Abstract Database was used to identify acute care hospitalizations with a primary diagnosis of syncope between fiscal years (FY) 2004 and 2015 in all provinces and territories (except Quebec). We used multiple linear regression to calculate the trends in prevalence of hospital admissions and generalized linear regression to estimate the costs of a hospitalization. The syncope hospitalization rate and the cost per hospitalization in Quebec were assumed to be the average of the rest of the country. The future hospitalization cost burden of syncope was projected to 2030.

Syncope is a challenging presentation because it can represent multiple underlying conditions. Concern for a cause that may result in serious morbidity and mortality often results in a hospital admission.¹ Although hospitalization allows for cardiac monitoring and expedites testing and specialist evaluation, anywhere from one-third to one-half of all patients have unexplained syncope at discharge.^{2,3}

Several small single-center studies have reported on the high costs associated with a hospital evaluation for syncope.⁴⁻⁶ When the mean cost of admission was converted to US dollars to allow for comparison, those estimates ranged from \$1700 in the United Kingdom⁴ to \$16,000 in Spain.⁶ A single study

RÉSUMÉ

Contexte : Des études monocentriques ont mis en lumière les coûts élevés associés à l'évaluation hospitalière d'une syncope. Les estimations nationales du coût des hospitalisations liées aux syncopes sont rares, et il n'en existe aucune au Canada.

Méthodologie : La base de données sur les congés des patients de l'Institut canadien d'information sur la santé a été utilisée pour recenser les hospitalisations de courte durée liées à un diagnostic primaire de syncope entre les années financières (AF) 2004 et 2015 dans toutes les provinces et territoires (sauf le Québec). Nous avons eu recours, d'une part, à la régression linéaire multiple pour calculer les tendances de la prévalence d'admissions à l'hôpital et, d'autre part, à la régression linéaire généralisée pour estimer les coûts d'une hospitalisation. Le taux d'hospitalisations liées à une syncope et le coût par hospitalisation au Québec ont été établis hypothétiquement à la

from approximately 20 years ago conducted in the United States provides the only national estimate for the overall annual hospitalization cost burden of syncope, estimated at \$2.4 billion (US) dollars.⁷

Compared with other countries, admission rates in Canada are significantly lower (12%-15%).^{8,9} However, a study performed in Alberta found regardless of emergency department (ED) discharge status (home vs hospitalization), the largest proportion of annual costs for syncope patients was attributed to hospitalizations.⁸ At present, the current and future cost burden of syncope hospitalizations in Canada are unknown. Accordingly, we estimated costs of acute care hospitalizations with a primary diagnosis of syncope in Canada between 2004 and 2015 and extrapolated the future cost burden to 2030.

Methods

Data source and study population

The Canadian Institute for Health Information Discharge Abstract Database (DAD) was used to identify hospitalizations

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Ethics Statement: The research reported in this paper adhered to relevant ethical guidelines.

Corresponding author: Dr Dat T. Tran, Institute of Health Economics, #1200 – 10405 Jasper Avenue, Edmonton, Alberta T5J 3N4, Canada. Tel.: +1-780-448-4881; fax: +1-780-448-0018.

E-mail: dttran@ualberta.ca

See page 227 for disclosure information.

Results: There were 128,263 hospitalizations for a primary diagnosis of syncope over the 10-year study period, resulting in a total cost of \$619.9 million (Canadian). An estimate of 41,044 syncope hospitalizations occurred in Quebec, costing \$198.7 million. The total hospitalization cost of syncope in Canada was estimated at \$818.5 million. The annual costs of syncope hospitalizations increased from \$66.6 to \$68.5 million between FY2004 and FY2015, respectively, and are projected to increase to \$87.1 million in 2030.

Conclusion: Hospitalization costs for syncope in Canada are high and rising. Research is needed to identify opportunities to deliver more efficient and cost-effective care.

with a primary diagnosis of syncope (International Classification of Diseases [ICD], 10th revision, code R55) between April 2004 and March 2016 (fiscal years [FY] 2004-2015). The ICD-10 code R55 has been found to have a sensitivity of 62.7% and a specificity of 99.9% and used in research previously.^{8,10-13} The DAD includes data on patient demographics, diagnoses, discharge disposition, case mix group classification (to identify homogenous patient clusters), and resource intensity weights (RIW), which indicate the level of a patient's resource consumption during a hospital stay, contingent on diagnostic case mix group.^{14,15} The DAD contains complete hospitalization data for all Canadian provinces and territories except Quebec.¹⁵

Main outcomes

The main outcomes were annual syncope hospitalization costs in Canada from FY2004 to 2015. Other outcomes included distribution of hospitalization costs by province, sex, and age groups (<60, 60-69, 70-79, and ≥80 years) and projections of annual syncope hospitalization costs in Canada to FY2030.

Hospitalization costs in Canada between FY2004 and 2015 (except Quebec)

Hospitalization cost refers only to costs incurred after admission from the ED. We estimated the cost of a hospitalization by multiplying the RIW with the Canadian cost of a standard hospital stay (CSHS).¹⁶ The CSHS provides the average costs incurred through the direct care of a standard hospitalization (RIW = 1.00) (e.g., nursing, diagnostic, and therapeutic costs).¹⁴ The CSHS is only available from FY2011 to 2015 (Supplementary Table S1);¹⁶ therefore, we estimated the costs of a syncope hospitalization between FY2004 and 2010 as follows: First, we developed a generalized linear model (GLM) with gamma distribution and log link to calculate the average costs per syncope hospitalization for each year during FY2011 to 2015. This methodology has been reported in detail.¹⁷⁻¹⁹ In brief, the gamma distribution was selected on the basis of the Modified Park test ($\lambda = 2$).²⁰ The independent variables included FY and patient sex and age groups. We then applied the GLM model's coefficients to estimate average costs per hospitalization for the years for which CSHS data were

moyenne du reste du pays. Le futur fardeau du coût des hospitalisations liées à une syncope a été projeté jusqu'en 2030.

Résultats : Nous avons recensé 128 263 hospitalisations liées à un diagnostic primaire de syncope au cours de la période de 10 ans à l'étude, ce qui se traduit par un coût total de 619,9 M\$ (canadiens). Selon une estimation, 41 044 hospitalisations liées à une syncope seraient survenues au Québec, au coût de 198,7 M\$. Le coût total des hospitalisations liées à une syncope au Canada a été estimé à 818,5 M\$. Les coûts annuels des hospitalisations liées à une syncope ont augmenté, passant de 66,6 à 68,5 M\$ entre les AF 2004 et 2015, respectivement, et ils devraient encore augmenter pour atteindre 87,1 M\$ en 2030.

Conclusion : Les coûts des hospitalisations liées à une syncope au Canada sont élevés et en hausse. D'autres travaux de recherche devront être effectués pour cerner les possibilités de prestations de soins plus efficaces et rentables.

not available (FY2004-2010). The costs of individual hospitalizations for each FY in each province were then summed to have annual syncope hospitalization costs for each province (except Quebec) between FY2004 and 2015.

Hospitalization costs in Quebec between FY2004 and 2015

In the absence of hospitalization data from Quebec, we assumed syncope hospitalization rates in the province to be the average hospitalization prevalence rates observed across the rest of the country for each sex and age group combination. We applied the average prevalence rates to the Quebec population to estimate the number of syncope hospitalizations each year during FY2004 to 2015.²¹ The annual syncope hospitalization costs in Quebec were then derived by multiplying the number of hospitalizations with average costs per hospitalization (from the GLM model described) for each FY for each specific sex and age group. This method has been used to estimate the costs of other conditions previously.^{22,23}

The average hospitalization prevalence rates were estimated as follows. We first calculated the syncope hospitalization prevalence rates per 100,000 population for each combination group of sex and age each FY during FY2004 to 2015 for the rest of Canada and then used multiple linear regression (MLR) to estimate the average prevalence rates during this time period. The outcome variable of the MLR model was a natural logarithm of the prevalence rate, and the covariates in the model were FY, sex, and age group. We used likelihood ratio test to examine inclusion of sex/age interaction. Interaction remained in the final model if the likelihood ratio test was significant at a 5% level. Model assumptions (homoscedasticity, normality of residuals, and the linearity of relationships between the outcome and FY as a continuous predictor) were checked and explored for unusual and influential observations by examining residuals and leverage values. We summed annual hospitalization costs in each province to estimate the Canadian hospitalization costs between FY2004 and 2015.

Hospitalization costs in Canada between FY2016 and 2030

To estimate future costs, we assumed that the trends seen from FY2004 to 2015 would continue. We used the MLR

Table 1. Baseline statistics of patients with syncope hospitalized, 2004-2015 (excluding Quebec)

Variable	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Admissions, N	10,374	10,234	10,233	10,154	10,273	10,359	10,654	10,873	11,474	11,505	11,195	10,935
eLOS, mean (SD)*	2.9 (1.6)	3.3 (1.7)	3.3 (1.6)	3.3 (2.1)	3.2 (1.8)	3.2 (1.7)	3.2 (1.7)	3.2 (2)	3.3 (2)	3.4 (2)	3.5 (2.4)	3.3 (1.9)
Male, n (%)	5263 (50.7)	5140 (50.2)	5193 (50.7)	5149 (50.7)	5269 (51.3)	5316 (51.3)	5367 (50.4)	5648 (51.9)	5958 (51.9)	5996 (52.1)	5891 (52.6)	5842 (53.4)
Age, mean (SD)	70.0 (18)	70.0 (18.3)	70.1 (18.3)	70.2 (18.4)	69.8 (18.7)	69.5 (18.9)	70.0 (18.4)	70.3 (18.5)	69.9 (18.8)	70.0 (18.7)	70.4 (18.7)	70.1 (18.7)
Age group, n (%) [†]												
<60 y	2365 (22.8)	2359 (23.1)	2319 (22.7)	2253 (22.2)	2367 (23)	2491 (24)	2481 (23.3)	2515 (23.1)	2707 (23.6)	2658 (23.1)	2492 (22.3)	2501 (22.9)
60-69 y	1466 (14.1)	1373 (13.4)	1379 (13.5)	1466 (14.4)	1507 (14.7)	1529 (14.8)	1615 (15.2)	1643 (15.1)	1771 (15.4)	1827 (15.9)	1792 (16)	1727 (15.8)
70-79 y	2822 (27.2)	2699 (26.4)	2640 (25.8)	2598 (25.6)	2547 (24.8)	2511 (24.2)	2546 (23.9)	2518 (23.2)	2655 (23.1)	2653 (23.1)	2589 (23.1)	2595 (23.7)
≥80 y	3721 (35.9)	3803 (37.2)	3895 (38.1)	3837 (37.8)	3852 (37.5)	3828 (37)	4012 (37.7)	4197 (38.6)	4341 (37.8)	4367 (38)	4322 (38.6)	4112 (37.6)
Selected comorbidity, n (%)												
Heart failure	422 (4.1)	406 (4)	388 (3.8)	386 (3.8)	389 (3.8)	421 (4.1)	452 (4.2)	452 (4.2)	521 (4.5)	511 (4.4)	537 (4.8)	451 (4.1)
COPD	394 (3.8)	416 (4.1)	416 (4.1)	396 (3.9)	421 (4.1)	419 (4)	504 (4.7)	477 (4.4)	515 (4.5)	503 (4.4)	501 (4.5)	449 (4.1)
Dementia	430 (4.1)	486 (4.7)	526 (5.1)	474 (4.7)	489 (4.8)	527 (5.1)	582 (5.5)	551 (5.1)	596 (5.2)	618 (5.4)	583 (5.2)	544 (5)
Diabetes	1185 (11.4)	1207 (11.8)	1684 (16.5)	1819 (17.9)	1925 (18.7)	1928 (18.6)	2043 (19.2)	2122 (19.5)	2330 (20.3)	2297 (20)	2311 (20.6)	2,299 (21)
Renal disease	370 (3.6)	424 (4.1)	379 (3.7)	391 (3.9)	436 (4.2)	359 (3.5)	360 (3.4)	363 (3.3)	418 (3.6)	399 (3.5)	459 (4.1)	497 (4.5)

AMI, acute myocardial infarction; COPD, chronic obstructive pulmonary disease; eLOS, expected length of stay; SD, standard deviation.

*eLOS is the number of days in the hospital assigned to each admission based on Canadian Institute for Health Information grouping methodology.

[†]Total proportion may not be exactly 100% because of rounding.

Table 2. Hospitalization costs for syncope by province in Canada (except Quebec, in million, 2018 CA\$ values), 2004-2015

Province	All	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Alberta	57.1	4.2	4.9	4.1	4.2	4.2	4.4	4.4	5.3	6.0	5.2	5.3	4.9
British Columbia	114.6	8.0	7.8	8.4	8.5	9.0	9.3	9.9	9.3	11.0	11.3	11.3	10.8
Manitoba	20.6	1.9	1.9	1.8	1.7	1.6	1.5	1.7	1.6	1.6	1.9	1.7	1.9
New Brunswick	33.1	2.7	2.7	3.0	3.1	2.8	2.6	2.8	2.7	3.1	2.5	2.8	2.3
Newfoundland and Labrador	16.3	1.0	1.2	1.1	1.1	1.3	1.1	1.3	1.3	1.7	1.6	1.8	1.9
Nova Scotia	22.9	2.1	1.9	1.8	1.7	1.8	1.8	1.9	2.5	2.0	2.4	1.6	1.6
Ontario	314.4	27.6	26.4	26.6	25.8	25.6	25.9	26.2	26.5	26.8	26.5	25.8	24.7
Prince Edward Island	4.3	0.3	0.4	0.3	0.4	0.3	0.4	0.3	0.5	0.4	0.4	0.4	0.2
Saskatchewan	35.2	3.2	3.0	3.2	3.1	3.1	3.0	2.8	2.7	3.1	2.6	2.6	2.6
Territories	1.3	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total	619.9	51.2	50.4	50.3	49.7	50.0	50.0	51.3	52.6	55.7	54.4	53.5	50.9

and GLM models' coefficients to calculate hospitalization prevalence rates and costs per hospitalization for each sex and age group for each FY between FY2016 and 2030. The estimated prevalence rates were multiplied by the Canadian population (medium growth [M5] scenario) to calculate the number of syncope hospitalizations annually until FY2030.²⁴ We multiplied the estimated number of hospitalizations by the costs per hospitalization to estimate annual syncope hospitalization costs between FY2016 and 2030 in Canada.

Sensitivity analysis

We conducted 2 sensitivity analyses. First, we included only hospitalizations for a primary diagnosis of syncope in the main analysis. We performed another analysis in which both primary and secondary diagnosed syncope hospitalizations were included. Second, we used the medium growth scenario (M5) for projected Canadian population in the main analysis of hospitalization costs for syncope between FY 2016 and 2030.²⁴ We conducted an additional analysis of hospitalization costs during this period using low and high growth scenarios to examine impact of population growth on hospitalization costs for syncope in Canada.

Statistical analysis

Patient characteristics were summarized using count, percentage, mean (±standard deviation), and median (interquartile range), as appropriate, and were reported each FY during the study period. Previously validated ICD codes were used to identify patient comorbidities.²⁵ Comorbidities in a given FY were considered to be present if they were recorded in any hospitalization during that FY. Univariate GLM regression was used for trend test of costs. All costs in this study were inflated to 2018 Canadian dollar values using Canadian Consumer Price Index.²⁶

Table 3. Hospitalization costs for syncope in Canada (except Quebec) between FY2004 and 2015 by sex and age (in million, 2018 \$ values)

Age group	All	Female	Male
<60 y	106	44.3	61.6
60-69 y	81.8	30.7	51.1
70-79 y	153.7	69.9	83.8
≥80 y	278.3	158.5	119.8
Total*	619.9	303.5	316.4

*Total costs may not be exactly the same as the sum of its subgroups because of rounding.

All analyses were performed using Stata version 14 (Stata Corp., LP, College Station, TX). Two-sided *P* values < 0.05 were considered statistically significant. The study was approved by the Health Research Ethics Board at the University of Alberta (Institutional Review Board Number: Pro00072777).

Results

Baseline characteristics

A total of 128,263 syncope hospitalizations for 116,630 unique patients occurred between FY2004 and 2015 in Canada (less Quebec). Hospitalizations for men increased (2004: 50.7%, 2015: 53.4%, *P* < 0.001), whereas mean patient age remained unchanged (70 years, *P* = 0.26) during the study period. The most prevalent comorbidity was diabetes, and it increased over time (2004: 11.4%, 2015: 21%, *P* < 0.001), as did the expected length of stay (2004: 2.9 days, 2015: 3.3 days, *P* < 0.001) (Table 1). The number of syncope hospitalizations by province is presented in Supplementary Table S2.

Hospitalization costs in Canada (except Quebec) between FY2004 and 2015

Syncope cost the Canadian health systems (except Quebec) \$619.9 million in hospital services between FY2004 and 2015, of which Ontario accounted for the largest proportion (50.7%), followed by British Columbia (18.5%) and Alberta (9.2%). Annual hospitalization costs increased from \$51.2 million in FY2004 to a peak of \$55.7 million in FY2012, and then decreased to \$50.9 million in FY2015 (Table 2). Total hospitalization costs for male patients were higher than those for female patients, primarily due to higher prevalence rates in male patients, and hospitalization costs for the most senior group (aged ≥ 80 years) accounted for the majority in both sexes (Table 3 and Fig. 1). Results of the GLM model and estimated average costs per syncope hospitalization are presented in Supplementary Tables S3 and S4, respectively.

Hospitalization costs in Quebec between FY2004 and 2015

Extrapolating the syncope hospitalization rates in the rest of Canada (Fig. 1) to Quebec population resulted in 41,044 hospitalizations with a primary diagnosis of syncope in Quebec between FY2004 and 2015, corresponding to a total cost of \$198.7 million during this period (Supplementary Table S5). By adding Quebec, the annual hospitalization costs countrywide were \$66.6 million in FY2004 and

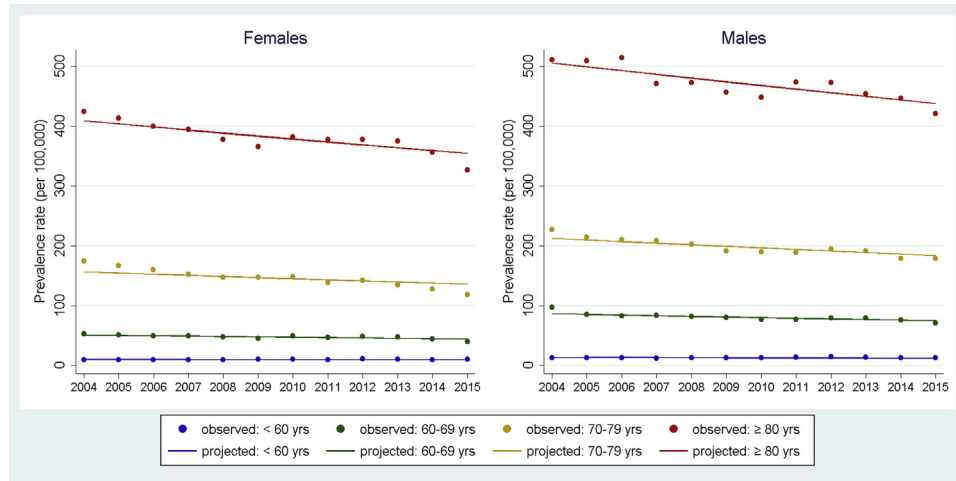


Figure 1. Syncope hospitalization prevalence rates in Canada (except Quebec), 2004-2015.

increased to \$68.5 million in FY2015. The total costs of syncope hospitalization in Canada during this period were \$818.5 million (Fig. 2). Detailed results of the MLR model and estimated syncope hospitalization prevalence rates per 100,000 populations by sex and age are presented in Supplementary Tables S6 and S7, respectively.

Hospitalization costs in Canada between FY2016 and 2030

Although rates of hospitalization decreased over time (Fig. 1, $P < 0.001$), the absolute number of syncope hospitalizations in Canada is projected to increase from 14,620 in 2015 to 18,793 in 2030 (Supplementary Table S8), primarily

due to a composite effect of population growth and ageing. Accordingly, the hospitalization costs were projected to increase from \$68.5 million in 2015 to \$87.1 million in 2030 (Fig. 2).

Sensitivity analysis

Including both primary and secondary diagnoses, hospitalization costs increased to \$242.9 and \$426 million in 2015 and 2030, respectively. Low and high population growths corresponded to a range of hospitalization costs for syncope as the primary diagnosis of \$84.2 to \$91.1 million in 2030.

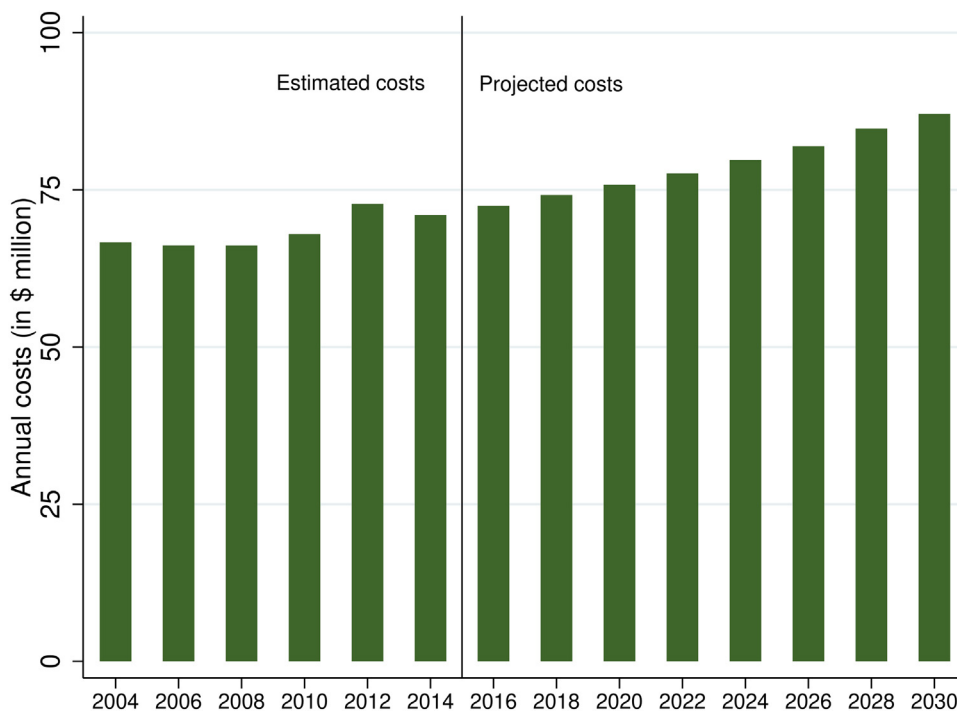


Figure 2. Syncope hospitalization costs in Canada (in million, 2018 \$ values), 2004-2030.

Discussion

This contemporary study provides the first costs estimate of syncope-related hospitalization in Canada. We estimated hospitalizations with a primary diagnosis of syncope over a 10-year period cost the Canadian health systems \$818.5 million dollars. The annual hospitalization costs have been increasing over time and are projected to increase 27% by 2030. When both primary and secondary diagnoses of syncope were considered, the hospitalization costs in Canada are expected to increase 5-fold to \$426 million in 2030.

Syncope hospital services alone accounted for 0.1% of national hospital spending in 2015.²⁷ Even though the hospitalization cost burden is not comparable to other conditions, such as heart failure (HF) or congenital heart disease,^{23,28} the overall cost burden of syncope in Canada is considerable given only approximately 10,000 patients with syncope are admitted annually, much less compared with patients with HF. Measures are needed to respond to the projected increasing costs of syncope. In a nationwide study, we previously demonstrated that approximately two-thirds of hospitalized patients are without any comorbidity (Charlson comorbidity score = 0).¹³ Strategies aimed at reducing unnecessary admissions among low-risk patients are needed. This may include community interventions (e.g., risk stratification performed by emergency medical services or establishing care pathways for urgent referrals to appropriate outpatient clinics) or interventions within the ED (e.g., a dedicated syncope management unit).²⁹ Regardless of the intervention, research is needed to identify a cost-effective strategy that is feasible for a Canadian healthcare system.

Unlike other cardiovascular conditions, such as acute myocardial infarction, where hospitalization costs account for as much as 81% of the total healthcare cost burden,^{18,19} outpatient services may be the driver of the cost burden for syncope. Epidemiological studies have shown that of the patients who have a syncope event and are seen in the outpatient setting, only a small fraction of syncope patients are referred to the ED.^{30,31} Although the DAD does not provide costs beyond hospitalization, a study performed in Alberta was able to perform a comprehensive evaluation of syncope-related costs (outpatient, physician claims, and drugs) and found anywhere from 26% to 52% of costs depending on whether patients were discharged or hospitalized were nonhospital related.⁸ This study also found that 85% of patients presenting with a primary diagnosis of syncope to the ED are discharged, so further research is needed to quantify the costs related on this setting because these data suggest cost-saving interventions for this subgroup of patients may be an cost-effective strategy.

We found that the syncope hospitalization costs per capita in Canada (\$2 in 2005, in \$ 2018 values) were lower than in the United States (\$4.9 in 2005, converted to Canadian dollar 2018 values^{7,32-34}). This may stem from differences in practice between the 2 countries. Compared with Canada, the United States has had higher rates of ED presentation and hospital admissions for syncope.^{8,35,36} In addition, the costs per a health service encounter for syncope vary significantly depending on local practice standards, types of evaluation, testing, and whether intervention is required.³⁷ We found the hospital costs were higher for men compared with women, which is explained by sex differences in admission rates. Our prior work^{8,13,38} and others³⁹ have found that men were more

likely to be admitted than woman and admission among men had increased over time.

Limitations

Although our study provides novel data on syncope hospitalization cost burden in Canada, it has limitations. First, we assumed that the trends seen between 2004 and 2015 would continue when projecting future costs. We provided 95% confidence intervals (presented in the Supplementary Material) and low and high estimates of population growths to account for uncertainty. Second, we lacked hospitalization data from Quebec and assumed that the rate of hospitalization in Quebec would be the same as the rest of Canada. We examined variations across the provinces and found no statistically significant differences in hospitalization rates across provinces for which we have data. Third, the national database did not allow for quantifying the type/number of tests and specialist evaluations performed during hospitalization. These data may help to identify an opportunity to reduce cost. Finally, the sensitivity of 62.7% for the code R55 suggests that the true cost burden of syncope in Canada could be substantially higher.

Conclusions

Syncope cost the Canadian healthcare system \$818.5 million in hospital services from 2004 to 2015. The annual hospitalization costs have been increasing and are projected to increase 27% by 2030. To reduce costs, further research is needed to identify strategies to deliver more efficient syncope care in acute care settings.

Contributors

Dat Tran, Padma Kaul, and Roopinder Sandhu conceptualized the study. Dat Tran conducted the analyses and drafted the manuscript. All of the authors critically reviewed the manuscript for intellectual content. Dat Tran had full access to the data and serves as the guarantor of the work.

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Disclosures

The authors have no conflicts of interest to disclose.

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Supplementary Material

To access the supplementary material accompanying this article, visit the online version of *CJC Open* at <https://www.cjcoopen.ca/> and at <https://doi.org/10.1016/j.cjco.2020.02.009>.