

ESTIMATING CANADIAN HEART FAILURE PREVALENCE USING PRESCRIPTION TREATMENT PATTERNS



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BACKGROUND

Heart failure (HF) is a complex clinical syndrome where the heart cannot pump enough blood to maintain the metabolic needs of tissues and organs¹. HF has been shown to negatively impact a patient's quality of life by affecting their physical, psychological, social, and economic status². Despite currently available therapies for HF, both mortality and hospitalization remain high^{3,4}. Approximately 22,000 deaths per year occur due to HF, comparable to the number of annual deaths from breast, colorectal, prostate and pancreatic cancer combined^{5,6}. HF presents a challenge to the healthcare system as it is the most common cause of inpatient hospitalization in patients aged 65 or older, and prior cost studies demonstrated a substantial cost per HF hospitalization^{7,8}.

Approximately 600,000 Canadians are diagnosed with HF, however existing Canadian HF prevalence estimates use hospital and, where available, primary care diagnosis from databases which are limited in coverage and availability⁹. As HF has a large impact on the Canadian healthcare system, it is important to have up-to-date prevalence estimates.

PURPOSE

This study will provide recent and nationally robust Canadian prevalence rates for treated HF using a predictive model applied to a national prescription database.

DATA SOURCE

IMS Brogan's (IMS) E360 Canadian Electronic Medical Record (EMR) database:

- A primary care medical record database housing approximately 1,000,000 patient medical records from Ontario – Canada's largest province – including diagnosis, laboratory values, and prescriptions.

IMS Brogan's Longitudinal (LRx) database:

- A national retail pharmacy based dispensed prescription database projected to 100% coverage.

METHODS

Phase 1: Develop and test predictive model

- A Classification and Regression Tree (CART) model predicting HF prescription patterns was constructed using the IMS E360 EMR database.
- As it has been shown that class imbalance between the two cohorts, HF and non-HF, may result in poorer model accuracy, the dataset was balanced by randomly selecting non-HF patients for study inclusion resulting in an approximate 1:1.25 ratio of HF to non-HF patients¹⁰.
- Age, gender, prescriptions, referrals, and physician specialty variables were used in developing the CART model.
- To aid in preventing overfitting, a minimum of 25 patients per final node was required.
- After training, the CART model's HF predictive accuracy was validated using a naïve test dataset of approximately 15% of the HF patients to establish the model's accuracy, positive and negative predictive values (PPV and NPV).
- Clinical opinion was engaged to confirm the rules generated by the statistical model.

Inclusion criteria – Phase 1

- Aged ≥18.
- ≥1 Anatomical Therapeutic Classification (ATC)-1 cardiovascular prescription.
- ≥2 doctor visits between January 2006 - January 2015.
- ≥1 HF diagnosis (International Classification of Diseases – Ninth Revision 428) used to positively identify a heart failure patient.

Phase 2: Application of predictive model to national LRx dataset

- To identify national HF patients, the CART model was applied to the national LRx dataset.
- All patients with >6 months follow-up in the LRx dataset were used to identify the prevalence of treated HF patients by age group.
- The CART model's estimated prevalence of HF was then validated against current Canadian HF literature sources.

Inclusion criteria – Phase 2

- Aged ≥18.
- >6 months follow-up.

RESULTS

Patients and Variables

- 675 HF patients and 840 randomly sampled non-HF patients were included in the analysis (Figure 1).
- In the EMR dataset, HF patients were predominantly senior and obese (Table 1).
- Age and standardized duration treated with beta-blockers, ACEs/ARBs, high ceiling diuretics, or vasodilators were strong indicators of a HF diagnosis, while physician referral and gender variables were not.

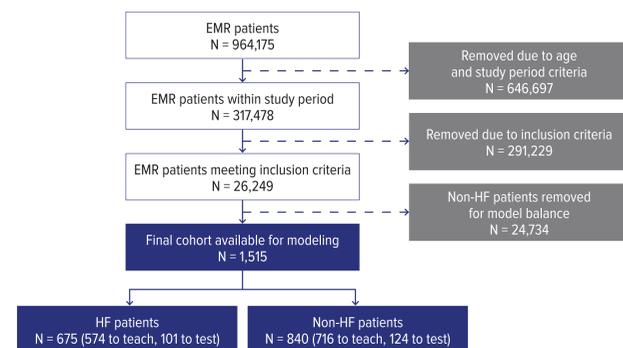


Figure 1. 1,515 patients were included in the study with approximately 15% reserved as a test set

Table 1. Baseline characteristics of HF patients used in the CART model

| HF Patients Baseline Characteristics | Value |
|--------------------------------------|------------------------|
| 60+ years old (%) | 87.8% |
| Female | 45.1% |
| Weight (median) | 79.1 kg |
| BMI (median) | 28.6 kg/m ² |
| Total Cholesterol (median) | 4.08 mmol/L |
| Baseline Cholesterol >5.2 mmol/L | 25.4% |
| Diastolic BP (median) | 77 mm/Hg |
| Systolic BP (median) | 132 mm/Hg |
| Blood Glucose A1c (median) | 6.0% |
| Blood Glucose A1c > 6.5% | 28.7% |
| Diagnosed with Asthma or COPD | 21.1% |

Model Accuracy

- When validated on the test dataset, the model demonstrated an 80.0% accuracy, an 81.1% PPV, and a 79.5% NPV.
- A separate study found that a case definition of two HF diagnosis within all primary or secondary records or one HF diagnosis within all hospital records in a year had a positive predictive value of 55.6%⁹.
- 25.3% of the patients incorrectly identified as HF in the entire cardio prescription treated EMR dataset had a pre-HF diagnosis (e.g. hypertensive heart disease; old myocardial infarction; mitral insufficiency or stenosis; or pulmonary embolism with infarction).

Prevalence

- Overall, we estimated a 2014 national treated HF prevalence of 2.31%, or 657,902 patients aged ≥18 years (Table 2).

- Standardized by the 2014 Canadian population, we estimated an 18.5 per 1000 HF prevalence for those ≥18 years.
- Analyzing patients ≥40 years, we estimated a 2014 national HF patient count of 648,493.
- This estimate aligned well with literature population estimate for patients aged ≥40 - 590,416 and 626,199 patients^{9,11}. Literature sources were based on diagnosis codes, and did not indicate that the patients were treated for their HF.
- Elderly patients (aged ≥65 years) made up 76.08% of the 2014 HF patients with a prevalence of 8.97%, while those aged 18 to 64 years represent 23.92% of 2014 HF patients with a prevalence of 0.69%.
- Nationally, the 2014 prevalence was slightly higher in women (2.44%) compared to men (2.17%).

Table 2. Treated HF prevalence by age group and for the population aged ≥18 in Canada in 2014

| Categories | HF Predictive Model |
|---|---------------------|
| HF Population Aged ≥18 in Canada (2014) | 657,902 |
| HF Prevalence Aged ≥18 in Canada (2014) ¹² | 2.31% |
| AGE GROUP PREVALENCE | |
| 18-39 | 0.1% |
| 40-44 | 0.4% |
| 45-49 | 0.8% |
| 50-54 | 0.9% |
| 55-59 | 1.5% |
| 60-64 | 2.5% |
| 65-69 | 3.9% |
| 70-74 | 4.6% |
| 75-79 | 6.9% |
| 80-84 | 17.5% |
| 85+ | 23.8% |

CONCLUSION

We estimate 657,902 Canadians ≥18 years of age were treated for HF in 2014, which aligned well with literature prevalence estimates^{9,11}. This study strengthens the literature by updating HF prevalence estimates, and providing an additional triangulation point to identify the true population HF prevalence. Whereas estimates based on HF diagnosis codes alone may not capture patients who are treated for HF but do not have the diagnosis code recorded in their medical records, use of this treatment-based model will. The study's strength is that regardless of a recorded diagnosis, a treated HF patient will be included.

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