

Comparison of 1-year healthcare resource utilization and related costs for patients with heart failure in the Chagas and non-Chagas matched cohorts

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Abstract

Background: Chagas disease is one of the leading causes of heart failure (HF) in Latin Americans, and there are limited data available that examine related costs of care for patients with HF. This study aimed to compare healthcare resource utilization and related costs for patients with HF, with and without Chagas disease.

Methods: A prospective matched-cohort study comparing the healthcare costs for patients with HF with Chagas disease and care costs for patients with HF without Chagas disease was conducted between January 2019 and December 2019. Only direct costs have been estimated, including hospitalization costs, medications and other cardiovascular interventions, and clinical and laboratory follow-up for up to 1 year.

Results: A total of 80 patients with chronic HF were included in the study. Of the 80 patients, 40 patients in the Chagas cohort and 40 patients in the non-Chagas cohort were matched for age, insurer and sex. From a social security system perspective, the total costs for the two cohorts during the study period were U\$970,136. Specifically, the healthcare costs for the Chagas cohort were greater than the total healthcare costs for the non-Chagas group (U\$511,931 versus U\$458,205; $p = 0.6183$) Most costs were associated with hospitalizations (65.5% versus 59.6%), with averages of U\$12,798.5 and U\$11,455.1 per person in the Chagas and non-Chagas groups, respectively. In both the Chagas (51.6%) and non-Chagas cohorts (54.5%), causes of readmission unrelated to HF outweighed causes of readmission related to HF. High incidences of hospital admissions were observed during the rainy (cold) season for both cohorts

Conclusions: Over a 12-month follow-up period, patients with chronic HF and Chagas consume as many healthcare resources as those with chronic HF and without Chagas. These data highlight the considerable and growing economic burden of HF on the Colombian health system.

Keywords: Chagas disease, cost of illness, costs and cost analysis, healthcare costs, health expenditures

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Introduction

Heart failure (HF) is a life-threatening condition that imposes a substantial clinical and economic burden on healthcare systems around the world and is associated with increased morbidity and

mortality.¹ Over the last few decades, the prevalence of HF has increased considerably, which is, partly, explained by the aging population, therapeutic advances, and increased survival rates after diagnosis.^{2,3} Although prevalence data are

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limited, the most recent estimates suggest that approximately 64.3 million people worldwide suffer from HF.⁴ In addition to increasing prevalence, the economic impact of HF is substantial. In developed countries, the cost of care constitutes 1–2% of overall healthcare expenses, and efforts to lower care costs are nonexistent.⁵ This chronic and complex condition demands healthcare resources with high cost thresholds for healthcare services due to high rates of hospitalizations for patients with HF.⁶

HF is a final stage of several cardiovascular diseases; among them, Chagas disease is one of the most frequently associated causes of HF worldwide, affecting approximately 6 million people worldwide.⁷ This zoonotic disease caused by the *Trypanosoma cruzi* parasite is the most common cause of nonischemic cardiomyopathy in Latin Americans; older adults experience higher prevalences of the disease compared with prevalences of other age groups, which results in increased morbidity and greater demand for healthcare services.^{8,9} Estimating increased healthcare expenses associated with the growing prevalence of HF among older adults is complicated due to comorbid conditions, including Chagas disease.^{3,10} Further understanding of major costs associated with HF and Chagas disease would lead to future studies on strategies for improving care for both conditions.

Although the clinical importance of this comorbidity has been established, its economic burden in patients with HF has not been extensively investigated. Chagas disease imposes a substantial burden on society in the form of higher medical costs, diminished productivity, premature mortality, and diminished quality of life.^{10,11} In Colombia, it is estimated that the prevalence of Chagas disease is 2%, and HF is the most frequent cause of hospitalization in individuals over 65 years of age.⁹ Despite this estimation, there are limited studies that comprehensively evaluate the economic burden of HF and related comorbidities in the Colombian health system.^{12,13}

While international literature presents multiple reports related to the epidemiology and economic burden of HF,^{14–16} the publication of this profile in Colombia is limited, and there are no adequate registries on its prevalence and associated costs. It is necessary to determine a baseline that compares the direct costs associated with

the treatment of patients with HF with Chagas disease and without Chagas, both in their compensated and decompensated states, that is approached on an outpatient basis and demands hospital care, respectively. Within this context, the aim of this 1-year prospective study was to characterize and compare healthcare resource utilization and related direct costs for HF patients in the Chagas and non-Chagas matched cohorts in Colombia.

Materials and methods

Participants and procedures

A prospective matched-cohort study comparing healthcare costs associated with patients with HF with Chagas disease and without Chagas was conducted between January 2019 and December 2019. The economic evaluation was conducted using the social security system. Only direct costs have been estimated, including hospitalization costs, medications and other cardiovascular interventions, and clinical and laboratory follow-up, for up to 1 year.

Participants with HF ≥ 18 years of age were selected, who were screened for *T. cruzi* (with and without Chagas disease), and who had undergone routine follow-up at an outpatient facility in the Colombian National Institute of Health located in the city of Bogotá, Capital District. The date of first *T. cruzi* diagnosis was recorded as the index date. Patients were included in the cohort if they had chronic HF of ≥ 12 months duration, had New York Heart Association (NYHA) functional class IV, and had a left ventricular ejection fraction (LVEF) $\leq 40\%$. To avoid significant discrepancies in disease severity, comparator subjects were matched with cases by age, insurer and sex. Participants with histories of psychiatric disorders or participants who experienced a recent myocardial infarction or revascularization in the last 3 months were excluded. Selected patients were placed into one of two cohorts: those who were exposed to *T. cruzi* infection (Chagas cohort) and those not exposed (non-Chagas cohort).

All medical utilities and costs per patient within 12 months after the index date were measured for both Chagas and non-Chagas cohorts. Medical utilization included the number of inpatient admissions, outpatient visits, and emergency room visits. Medical costs included costs incurred

for inpatient services, outpatient services, emergency visits, and medications. All healthcare costs were reported as Colombian pesos (COP) and were converted to US dollars by the 2019/12/31 exchange rate (1 USD [U\$] = 3,277 COP)

Measurements

In the case of outpatient care for compensated HF, the identification of cost-generating events was carried out by reviewing the medical records of the cohorts of patients treated during 2019 in the specialized outpatient service in hospital institutions in Bogota, Colombia. Information on the frequency of follow-up consultations, clinical laboratory tests, diagnostic tests, and the prescription of medications was obtained from the clinical history of each patient.

The direct medical costs to the healthcare system were derived from the Individual Registries for Health Service Provision (RIPS). The RIPS is a national database run by the Colombian Ministry of Health and Social Protection that captures data (including unit costs) on medical visits and associated procedures and other services for every patient in Colombia. Medication costs were determined from the figures reported in the purchasing channel of the SISMED registry.

In the case of hospitalizations due to HF decompensation, the identification of cost-generating events was obtained by reviewing the consolidated lists and invoices of the cohorts of patients in hospital institutions in Bogotá. Records of patients with a primary discharge diagnosis of decompensated HF were considered eligible. Information was also obtained on the length of hospital stay.

According to the information available in the invoices, the costs were grouped according to the cost center that generated them (stay, medical fees, laboratories, diagnostic images, drugs, and supplies)

Data analysis

Demographics and baseline clinical characteristics were reported for each cohort. Descriptive statistics such as the mean and standard deviation (SD) or count and percentages were used to analyze patient characteristic variables and healthcare costs. The results were compared between patients with and without Chagas disease using

Student's *t*-test for continuous variables and the chi-square test for categorical variables. The hospital case-fatality rate was estimated for each cohort based on the proportion between the number of admissions related to all causes that evolved to death and the total number of admissions for all causes in 12 months. Statistical significance was defined at $p < 0.05$. All *p* values less than 0.05 were considered statistically significant. All statistical analyses were conducted with Stata version 14.0 (Stata Corporation LP, College Station, TX, USA).

Ethics

The study was conducted in conformance with the ethical principles of the Declaration of Helsinki and the Colombian Guidelines for Research with Human Participants. Written informed consent was obtained from all participants before enrollment in the study. The Research Ethics and Methodologies Committee of the National Institute of Health in Bogotá, Colombia, approved this study (protocol CEMIN 33-2017).

Results

Patient baseline characteristics

A total of 80 patients with chronic HF were included in the study. Of these, 40 patients in the Chagas cohort and 40 patients in the non-Chagas cohort matched for age, insurer and sex were used as comparator. Of the total patients, 50 patients were men (62.5%), the ages of patients ranged from 59 to 71 years old, and the mean age was 62.9 ± 2.5 years. Baseline patient demographics and comorbid conditions for both cohorts are reported in Table 1.

The mean age of the Chagas cohort was 62.4 ± 2.6 years, ranging from 59 to 70 years. The age of the comparison group ranged from 61 to 71 years, with a mean age of 63.3 ± 2.4 years. The average length of hospital stay was $8.7 \text{ days} \pm 17.3$ and $8.1 \text{ days} \pm 16.5$ for the Chagas and non-Chagas cohorts, respectively. The hospital readmission rate was 55.0% within 12 months of follow-up in the Chagas cohort (see Table 2).

Regarding the causes for hospital readmissions, 51.6% and 54.5% of hospital readmissions were due to noncardiovascular causes in the Chagas

Table 1. Comparison of demographic and clinical characteristics of Chagas cases and Chagas-free comparators.

Characteristic	Patients with Chagas (N = 40)	Patients without Chagas (N = 40)	p value
Age in years, mean ± SD	62.4 ± 2.6	63.3 ± 2.4	0.110
Sex, male, n (%)	25 (62.5)	25 (62.5)	
Risk factors and comorbidities			
Atrial fibrillation, n (%)	15 (37.5)	6 (15.0)	0.022
Body mass index (kg/m ²)	27.4 ± 2.7	28.3 ± 2.4	0.141
Chronic respiratory disease, n (%)	10 (25.0)	12 (30.0)	0.617
Current smokers, n (%)	9 (22.5)	7 (17.5)	0.572
Diabetes mellitus, n (%)	18 (45.0)	26 (60.0)	0.179
Dyslipidemia, n (%)	17 (42.5)	20 (50.0)	0.501
Hypertension, n (%)	27 (67.5)	33 (82.5)	0.121
Implantable cardioverter-defibrillator, n (%)	8 (20.0)	1 (2.5)	0.029
Pacemaker, n (%)	12 (30.0)	3 (7.5)	0.020
Peripheral arterial disease, n (%)	9 (22.5)	6 (15.0)	0.390
Previous stroke, n (%)	7 (17.5)	5 (12.5)	0.774
Prior myocardial infarction, n (%)	18 (45.0)	10 (25.0)	0.061

Table 2. Type of clinical outcomes and their correlation with Chagasic or non-Chagasic cohorts.

Outcome	Patients with Chagas (N = 40)	Patients without Chagas (N = 40)	p value
Hospital readmission			
Within 1 year, n (%)	22 (55.0)	17 (42.5)	0.2447
All-cause mortality			
Within 1 year, n (%)	10 (25.0)	5 (12.5)	0.1521

and non-Chagas cohorts, respectively. Likewise, 38.7% and 40.9% of hospital readmissions were related to infections for both the Chagas and non-Chagas cohorts, respectively, occurred during the rainy (cold) season. The prevalence of comorbidities was high in both groups. Slightly more than half of the patients had a history of either diabetes or hypertension. Although the highest prevalence

was observed in the non-Chagas group, there were no significant differences. However, myocardial infarction and coronary heart disease were more common in the Chagas group. Other atherosclerotic diseases, such as peripheral arterial disease and stroke, were also more frequent in this group. Again, there were no significant differences between the two groups. Conversely, a history of atrial fibrillation, implantable cardioverter defibrillators, and pacemakers were significantly more common in patients with Chagas disease. It was also shown that chronic respiratory disease was common in both groups.

Health resource utilization and cost

The total costs for the cohort during the study period were U\$970,136, and the distribution of inpatient and outpatient costs are shown in Table 3. In general, healthcare costs for the Chagas cohort were greater than total healthcare costs for the comparator group (U\$511,931 versus U\$458,205;

Table 3. Comparison of healthcare resource utilization and healthcare costs of Chagas cases and Chagas-free comparators in 2019 (In USD).

Resource use/cost	Chagas (N = 40)	Non-Chagas (N = 40)	p value
HealthCare Resource Utilization			
Number of emergency room visits, mean (SD)	2.7 (3.6)	2.3 (3.1)	0.6573
Length of inpatient stay in days, mean (SD)	8.7 (17.3)	8.1 (16.4)	0.8873
Number of surgical procedures, mean (SD)	1.7 (2.6)	1.6 (2.3)	0.8400
Number of outpatient visits, mean (SD)	4.2 (3.5)	3.7 (5.8)	0.2218
Number of inpatient visits, mean (SD)	2.8 (4.8)	2.5 (4.7)	0.6820
Annual Costs			
Inpatient cost, mean (SD)	8,394.1 (12,532.8)	6,820.5 (14,240.8)	0.5909
Outpatient cost, mean (SD)	4,404.2 (7,321.9)	4,634.6 (6,271.1)	0.8772
Total cost (SD)	12,798.5 (14,279.2)	11,455.1 (14,354.4)	0.6922
Office visit cost, mean (SD)	227.3 (518.6)	188.1 (422.5)	0.7255
Emergency room visit cost, mean (SD)	97.8 (267.1)	84.3 (205.8)	0.7292
Inpatient pharmacy cost, mean (SD)	3,114.7 (5,177.3)	2,970.5 (4,489.2)	0.8939
Medical/surgical cost, mean (SD)	2,087.3 (4,486.1)	1,582.4 (3,751.4)	0.5468
Physical therapy cost, mean (SD)	504.2 (1,118.3)	393.2 (849.7)	0.6259
Laboratory investigations cost, mean (SD)	390.4 (984.7)	332.3 (821.7)	0.7826

$p=0.6183$). Most costs were due to hospitalizations (65.5% *versus* 59.6%), with averages of U\$12,798.5 and U\$11,455.1 per person in the Chagas and non-Chagas groups, respectively.

The highest proportion of inpatient costs were due to pharmacy utilization (mean, U\$3,114.7 *versus* U\$2,970.5 per person, Chagas and non-Chagas cohort) and procedures (mean, U\$2,087.3 *versus* U\$1,582.4 per person, Chagas and non-Chagas cohort). Total inpatient costs were U\$608,587 with averages of U\$8,394.1 and \$6,820.5 per person in the Chagas and non-Chagas cohorts, respectively.

The highest proportion of outpatient costs was due to physical therapy and rehabilitation (mean, U\$504.2 *versus* U\$393.2 per person, Chagas and non-Chagas cohort), and laboratory investigation (mean, U\$390.4 *versus* U\$332.3 per person, Chagas and non-Chagas cohort).

Discussion

This study provides the first detailed analysis of healthcare resource utilization and inpatient and outpatient costs of prevalent HF in people with Chagas disease compared with subjects of the same sex, insurer, similar age and with no history of Chagas disease in Colombia. In general, study participants with chronic HF and Chagas consumed as many healthcare resources as those with chronic HF and without Chagas during the 12-month study period. Likewise, in both groups, high readmission rates for noncardiovascular causes were observed. Hospitalizations were more frequent during the rainy (cold) season, and mainly due to infections.

The findings of the present study show that the costs for the cohort with Chagas are similar to the costs for the cohort without Chagas. However, Chagas disease leads to an additional cost burden on all medical care for patients with HF, mainly

inpatient care. Although the cost increase is not significant, a cooccurring diagnosis of Chagas disease for patients with HF may also lead to longer inpatient stays, perhaps as a result of medical and surgical complications. These results coincide with previous studies; in Mexico, the cost per patient with Chagasic cardiomyopathy varied from U\$4,463 to U\$11,839 depending on the type of admission.¹⁷ In Colombia, the cost of treating a patient with chronic Chagas disease ranged from U\$46.4 to U\$7,981, depending on the severity and level of care used.¹⁸ Another study in Colombia determined that the average costs of outpatient treatment and hospitalization for HF were U\$157 and U\$3,309, respectively.¹² Other studies reported an increase in costs relating to managing HF over time, up to 71%.¹⁹

Coinciding with previous findings in adult patients with HF, this study identified a high number of comorbidities associated with HF, such as diabetes mellitus, hypertension, and chronic obstructive disease, which implies a greater complexity of clinical management, an increase in the use of health services, and the cost of healthcare resources.^{3,20-22} The influence of these comorbid conditions on the economic burden for health services has been previously documented in other studies, in which it is estimated that the cost of the disease will continue to increase with the increasing prevalence of the disease over time, making the economic burden of HF associated with multiple chronic diseases complex.^{3,23}

As expected, the present study identified higher average costs for the treatment of worsening HF in the inpatient hospital setting compared with the outpatient setting, which is consistent with other analyses of HF costs.^{5,14,16,19} In this study, the hospital readmission rate at 12 months for all causes was higher in the Chagas cohort (55.0%). This finding aligns with previous reports in a retrospective cohort study conducted in Brazil, in which a similar hospital readmission rate of 54.1% was observed in a period of 1 year.²⁴ In contrast, findings differ from the results of a systematic review that estimated a rehospitalization rate of 31% at 12 months of follow-up.²⁵

Interestingly, this study found that the main cause of hospital readmissions in both cohorts was primarily non-HF-related admissions. This finding is consistent with previous studies that have

reported that given the high prevalence of other comorbid diseases in patients with HF, the number of admissions for noncardiovascular diagnoses increases.²⁶⁻²⁸ However, the findings differ from other studies that have reported those related to HF as the most frequent causes of hospital readmission, especially in patients with more severe presentations of HF. This result suggests the importance of having a greater focus on the management of noncardiovascular conditions in HF could help reduce hospitalization rates in these patients.²⁹

On the contrary, hospitalizations occurred more frequently during the rainy (cold) season, which is consistent with previous findings in patients with HF. In several countries, a higher incidence of cardiovascular disease has been reported during the rainy season, especially in the elderly.³⁰⁻³² This seasonal trend could be used to reinforce the importance of control measures and improve educational strategies that show the increased risk of cardiovascular diseases during the winter and rainy months.³³ In addition to reinforcing influenza and pneumococcal vaccinations, education should be provided that encourages adherence to treatments and physical activity, maintaining a healthy diet and reducing alcohol consumption. In general, these results show the need to account for the influence of environmental factors when implementing effective public health strategies.³³

Other determinants of hospital cost include length of hospital stay. In the present study, the length of hospital stay of the patients in both cohorts was 8 days. This result agrees with that reported in another study conducted in Colombia in which an average length of hospital stay of 8 days was reported.¹² In other investigations carried out in Colombia, median hospital stays of 9 days³⁴ have been reported in patients with decompensated HF, and a median of 5 days has been reported in patients with acute HF.¹³ In the latter, reports show that 65.7% of the patients had a prolonged stay of more than 7 days. In contrast, findings differ from other studies that have reported average hospital stays of 11 days.^{30,35}

An important aspect in the Chagas patient cohort is that antiparasitic drugs are ineffective in this phase of the disease. A clinical trial showed that benznidazole therapy did not have a favorable effect on Chagasic heart disease, nor did the therapy reverse the course of the disease.³⁶ Likewise,

some studies on drug safety have reported a high frequency of adverse events, and there are no precise recommendations on the monitoring of anti-trypanocidal drugs in clinical practice guidelines.^{37–39} Contrarily, this study presented a high mortality rate in the Chagas cohort, which coincides with the results estimated in a systematic review.²⁵ It is important to mention that the economic burden, due to premature mortality, has a negative impact, not only on health systems but also on society.⁴⁰ Early identification and effective management are required to reduce the risk of disease progression and associated health-care utilization and costs.¹⁰ In Colombia, the diagnosis and treatment of Chagas disease have universal healthcare coverage.⁴¹

The present study is limited in several ways. First, the patients may not be representative of patients receiving care in other settings. Second, the analysis focuses on direct medical costs from the perspective of the third-party payer, whereas patient out-of-pocket costs, direct nonmedical costs, and indirect costs were excluded. Third, the duration of the study was 12 months. The ideal is to start follow-up from the moment of diagnosis of HF.

In conclusion, during a 12-month follow-up period, patients with Chagas disease incurred similar costs and use of healthcare resources as those with chronic HF and without Chagas disease. These data highlight the considerable and growing economic burden of HF in the Colombian health system. The high hospital readmission rates and the fact that most of the associated costs for patients with HF are for admissions unrelated to HF are striking, which would have important therapeutic implications. Meanwhile, the implementation of action plans for the protection of health during the rainy seasons is relevant. It is important to continue early detection and treatment efforts of Chagas disease to prevent its progression and the financial burden on the health system.

Declarations

Ethics approval and consent to participate

The Research Ethics and Methodologies Committee of the National Institute of Health in Bogotá, Colombia, approved this study (protocol

CEMIN 33-2017). Written informed consent was obtained from all participants before enrollment in the study.

Consent for publication

Not applicable.

Author contributions

Mario J. Olivera: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Writing – original draft; Writing – review & editing.

Adriana Arévalo: Data curation; Formal analysis; Investigation; Methodology; Writing – original draft; Writing – review & editing.

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Competing interests

The authors declared no potential conflicts of interest with respect to the research, authorship or publication, or both, of this article.

Availability of data and materials

The data of this research are available upon request. Any researcher can formally request the data to the Research Ethics and Methodology Committee of the National Institute of Health in Bogotá, Colombia. Committee contact information, (mwisner@ins.gov.co).

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