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Research paper

Healthcare resource utilization and cost of obstructive hypertrophic cardiomyopathy in a US population

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ABSTRACT

Background: There are limited data evaluating all-cause and disease-related healthcare resource utilization (HCRU) and cost of care for patients with obstructive hypertrophic cardiomyopathy (oHCM).
Methods: This was a retrospective study using US longitudinal medical and pharmacy claims data during 2012–2020. Adults with ≥2 oHCM diagnoses were identified, with the first diagnosis date used as the index date. HCRU and costs of care were reported for the year preindex (baseline) and at 1- and 2-year follow-ups.
Results: We identified 1841 patients with oHCM (63 ± 15 years; 52% male). The mean number of hypertrophic cardiomyopathy (HCM)-related outpatient and cardiology visits increased from baseline to 1-year follow-up (2.3 vs. 7.8 and 0.6 vs. 2.2, respectively). At baseline, 8% of patients had ≥1 HCM-related inpatient hospitalization (mean 0.11 visits, 5.4 days length of stay), increasing to 27% postdiagnosis (mean 0.42 visits, 5.9 days length of stay). Total HCM-related costs increased from $5968 to $20,290 at 1-year follow-up, largely driven by inpatient hospitalization costs ($3889 vs. $14,369) and surgical costs ($2259 vs. $7217). The proportion with ≥1 HCM-related prescription increased from baseline (69%; mean fills 5.3) to 1-year follow-up (82%; mean fills 7.8). Pharmacy costs were generally low but also increased ($449 vs. $752).
Conclusions: This benchmark economic dataset for management and evaluation of patients with oHCM shows increased HCM-related costs over a 2-year period after oHCM diagnosis, driven by inpatient hospitalizations and surgical costs. Medication use was high, but costs were low, possibly reflecting use of generic multi-indication drugs for oHCM treatment.

1. Introduction

Contemporary management strategies for obstructive hypertrophic cardiomyopathy (oHCM), a common genetic cardiac disease, have resulted in the majority of patients achieving normal longevity and improved morbidity [1]. Current medical treatment consists of beta-blockers, verapamil, diltiazem, and disopyramide, as recommended in the 2020 American College of Cardiology Foundation/American Heart Association guidelines for the management of oHCM [2]. For patients with drug refractory symptoms, septal reduction therapies (septal myectomy or alcohol septal ablation) are warranted [3–5]. Patients at risk of sudden cardiac death may undergo placement of an implantable cardioverter defibrillator [6].

There are limited data on contemporary costs of management and resource utilization for patients with oHCM: the only aspects of oHCM management for which quantified cost has been reported are septal reduction therapies. Specifically, cost of hospitalization for alcohol septal ablation has been estimated at $18,760 [7], with an additional readmission cost postprocedure ($8433) [8]. The mean cost of hospitalization for septal myectomy has been estimated at $41,715 [9]. Beyond septal reduction therapy, the cost of oHCM management and total cost of illness remain unknown for patients in the United States. Establishing total and oHCM-related costs will increase our understanding of the economic burden of oHCM and provide decision-makers

Abbreviations: HCRU, healthcare resource utilization; HIRD, HealthCore Integrated Research Database; oHCM, obstructive hypertrophic cardiomyopathy.

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with important cost data for management considerations. Therefore, this study described all-cause and disease-related healthcare resource utilization (HCRU) and costs of care for US patients with oHCM.

2. Material and methods

2.1. Study design and population

This was a retrospective observational study utilizing claims data from the HealthCore Integrated Research Database (HIRD®). Patients were identified from the HIRD based on a review of their medical and pharmacy claims data. The HIRD is a large, administrative healthcare database for use in health outcomes and pharmacoepidemiologic research that contains geographically diverse longitudinal medical and pharmacy claims data from health plan members across the United States, representing over 50 million lives of commercially insured and Medicare Advantage members. The database represents claims information for one of the largest commercially insured populations in the United States and includes data on member enrollment, medical care (professional and facility claims), outpatient prescription drug use, outpatient laboratory test results data, and healthcare utilization.

The HIRD was queried from January 1, 2012, through January 31, 2020, to identify adult patients (≥18 years) with ≥2 claims of any hypertrophic cardiomyopathy (HCM) International Classification of Diseases, Ninth/Tenth Revision, Clinical Modification (ICD-9/10-CM) diagnosis codes: HCM: 425.1x, I42.1, I42.2; oHCM: 425.11, I42.1. For this study, oHCM was defined as having ≥2 oHCM diagnoses ≥7 days apart during the study period, and the index date was the first observed oHCM diagnosis date. Additionally, patients were only included if they had continuous medical and pharmacy health plan enrollment for ≥12 months preindex (baseline) and ≥24 months postindex (follow-up).

2.2. Analyses

Healthcare utilization was reported for the 12-month preindex period (baseline) and at 2 time periods after the index oHCM diagnosis (1- and 2-year follow-up). Specifically, the frequency and percentage of patients with ≥1 pharmacy or medical claim and the number of claims were reported. Healthcare medical encounters containing ICD-9/10-CM codes for any HCM diagnosis, atrial and ventricular arrhythmias diagnosis, or implantable cardioverter defibrillator procedures regardless of diagnosis were considered to be HCM-related. HCM-related prescription therapies included beta-blockers, verapamil, diltiazem, antiarrhythmics therapy, and anticoagulation therapy. HCM-related surgical procedures included septal reduction therapy, mitral valve surgery, implantable pacemaker, implantable cardioverter defibrillator, cardiac resynchronization therapy, and heart transplantation.

All-cause and disease-related HCRU for inpatient, emergency room, outpatient, skilled nursing facility, and pharmacy was presented as n (%) of patients with ≥1 visit and mean ± standard deviation of visits among all patients. Healthcare costs were analyzed as continuous variables with mean ± standard deviation. Costs were reported as medical, pharmacy, and total (sum of medical and pharmacy), and were the sum of plan paid, patient paid, and any coordination of benefit (2019 USD). Patient out-of-pocket costs included all co-insurance, deductible, co-payment, and other patient outlays related to specific medical or pharmacy claims. Analyses were undertaken with SAS, version 9.3 (SAS Institute Inc., Cary, NC, USA).

3. Results

3.1. Baseline patient characteristics

Among 1841 patients with oHCM, the average age was 63 ± 15 years, and 52% of the cohort were male (Table S1). The cohort included patients across the United States, with 31% from the Midwest, 23% from the South, 22% the West, and 22% from the Northeast; the region was unknown for 1% of patients. Health plan type included preferred provider organization (66%), health maintenance organization (27%), and consumer-driven health plan (7%), with 42% of patients also having Medicare Advantage/Supplemental & Part D.

3.2. Healthcare resource utilization

Given the method for defining an event as HCM-related, patients could have HCM-related resource use during the preindex period. After oHCM diagnosis, the proportion of patients hospitalized increased (Table 1), especially for HCM-related hospitalization (Table 2). During the preindex year, 8% of patients had ≥1 HCM-related inpatient hospitalization (mean 0.11 visits, length of stay 5.4 days), increasing to 27% postdiagnosis (mean 0.42 visits, length of stay 5.9 days). HCM-related hospitalizations accounted for 84% (first year) and 73% (second year) of all-cause hospitalizations after oHCM diagnosis, respectively. Although the overall proportion of patients visiting the emergency room for any reason remained stable (23–24%), HCM-related emergency room use increased from baseline (4%) to the postindex period (first year: 8%; second year: 6%).

Overall, office visits and pharmacy utilization increased after the oHCM diagnosis. Compared with baseline, the number of all-cause physician office visits increased from 9.5 (baseline) to 11.5 (first year), with 11% and 29% of visits being HCM-related, respectively. Preindex, 38% of cardiology specialist visits were HCM-related, rising to 72% in the first year after diagnosis and 66% in the second year (Fig. 1). The mean number of HCM-related outpatient and cardiology visits increased from baseline to 1-year follow-up (2.3 vs. 7.8 and 0.6 vs. 2.2, respectively), with 79% of patients having ≥1 cardiology visit during the 1-year follow-up. Patients with ≥1 HCM-related prescription fill increased from preindex (69%; mean fills 5.3) to 1-year follow-up (82%; mean fills 7.8). Patients received an average of 3 more HCM-related prescription fills per year after oHCM diagnosis. Although 24–30% of

Table 1
All-cause healthcare resource utilization in oHCM cohort ($n = 1841$).

Measure	Baseline	1-Year follow-up	2-Year follow-up
Inpatient hospitalization			
≥1 visit, n (%)	318 (17)	590 (32)	414 (22)
Number of visits, mean (SD)	0.3 (0.7)	0.6 (1.1)	0.4 (1.0)
Length of stay, days, mean (SD)	4.8 (4.4)	5.5 (5.8)	5.9 (7.1)
Emergency room visits[a]			
≥1 visit, n (%)	416 (23)	436 (24)	423 (23)
Number of visits, mean (SD)	0.3 (0.8)	0.4 (0.9)	0.4 (0.9)
Outpatient visits			
≥1 visit, n (%)	1808 (98)	1838 (100)	1817 (99)
Number of visits, mean (SD)	27.5 (30.1)	35.5 (35.4)	32.3 (35.0)
Physician office visits			
≥1 visit, n (%)	1784 (97)	1831 (99)	1794 (97)
Number of visits, mean (SD)	9.5 (8.3)	11.5 (8.5)	10.0 (8.0)
Cardiologist office visits			
≥1 visit, n (%)	1133 (62)	1629 (88)	1420 (77)
Number of visits, mean (SD)	1.7 (2.5)	3.1 (3.0)	2.2 (2.5)
Skilled nursing facility visits			
≥1 visit, n (%)	17 (0.9)	46 (2)	52 (3)
Prescription drug fills[b]			
Patients with ≥1 fill, n (%)	1750 (95)	1779 (97)	1766 (96)
Number of fills, mean (SD)	22.3 (17.2)	25.7 (18.2)	25.3 (18.4)

Abbreviations: HCM, hypertrophic cardiomyopathy; oHCM, obstructive hypertrophic cardiomyopathy; SD, standard deviation.

[a] Any emergency room visit that results in hospital inpatient admission will be captured as the latter.

[b] HCM-related prescription included beta-blockers, verapamil, diltiazem, antiarrhythmics therapy, or anticoagulation therapy.

Table 2
HCM-related healthcare resource utilization in oHCM cohort ($n = 1841$).

Measure	Baseline	1-Year follow-up	2-Year follow-up
Inpatient hospitalization			
≥1 visit, n (%)	155 (8)	494 (27)	302 (16)
Number of visits, mean (SD)	0.11 (0.4)	0.42 (0.9)	0.25 (0.7)
Length of stay, days, mean (SD)	5.4 (5.6)	5.9 (6.7)	6.5 (7.5)
Emergency room visits[a]			
≥1 visit, n (%)	70 (4)	144 (8)	115 (6)
Number of visits, mean (SD)	0.05 (0.3)	0.11 (0.5)	0.08 (0.3)
Outpatient visits			
≥1 visit, n (%)	689 (37)	1787 (97)	1449 (79)
Number of visits, mean (SD)	2.3 (5.7)	7.8 (14.3)	5.7 (13.5)
Physician office visits			
≥1 visit, n (%)	578 (31)	1660 (90)	1341 (73)
Number of visits, mean (SD)	1.1 (2.7)	3.4 (3.3)	2.3 (3.0)
Cardiologist office visits			
≥1 visit, n (%)	459 (25)	1463 (79)	1129 (61)
Number of visits, mean (SD)	0.6 (1.8)	2.2 (2.4)	1.4 (1.9)
Skilled nursing facility visits			
≥1 visit, n (%)	<10	24 (1)	14 (0.8)
Prescription drug fills[b]			
Patients with ≥1 fill, n (%)	1262 (69)	1509 (82)	1477 (80)
Number of fills, mean (SD)	5.3 (5.9)	7.8 (6.8)	7.2 (6.4)

Abbreviations: HCM, hypertrophic cardiomyopathy; oHCM, obstructive hypertrophic cardiomyopathy; SD, standard deviation.

[a] Any emergency room visit that results in hospital inpatient admission will be captured as the latter.

[b] HCM-related prescription included beta-blockers, verapamil, diltiazem, antiarrhythmics therapy, or anticoagulation therapy.

the prescription fills were HCM-related, 18–20% of patients did not receive any HCM-related medications during the 2 years after diagnosis (Table 2).

3.3. Cost of oHCM

The average all-cause total healthcare expenditure (including both medical and pharmacy costs) was $19,525 for the preindex year, $35,267 for the first year postindex, and $25,910 for the second year after oHCM diagnosis (Table S2). Compared with baseline, healthcare expenditures were, on average, $15,742 and $6386 higher in the first and second year after oHCM diagnosis, respectively. The increase was mainly driven by higher inpatient (first year, $10,593; second year, $3486) and outpatient care costs (first year, $3874; second year, $1789). Surgical procedure costs accounted for 14%, 27%, and 17% of total costs of care for the baseline, first year, and second year, respectively. Medication costs covered by pharmacy benefits during the first and second years after oHCM diagnosis were, on average, $716 to $954 higher than baseline medication costs.

HCM-related healthcare costs accounted for 31% (baseline), 58% (first year), and 46% (second year) of the total costs of care (Fig. 2). Total HCM-related costs increased from $5968 to $20,290 after diagnosis (Fig. 3), largely driven by inpatient hospitalization costs ($3889 vs. $14,369) and surgical costs ($2259 vs. $7217). HCM-related outpatient visit costs were generally low from baseline to 1-year follow-up: outpatient visit ($1472 vs. $4733), cardiologist office visit ($79 vs. $290), and diagnostic procedure ($628 vs. $2777). Additionally, pharmacy costs were low in general but also increased from baseline to 2-year follow-up ($449 vs. $752). HCM-related medication costs accounted for approximately 2% of total healthcare expenditures.

4. Discussion

There are limited data on contemporary costs of management for patients with oHCM. Therefore, the primary objective of this study was to describe all-cause and disease-related HCRU and costs of care for patients with oHCM in the United States. Our data suggest that both the all-cause and HCM-related HCRU increased from baseline to the first year and then decreased slightly in the second year after oHCM diagnosis. However, HCRU in the second year was still higher than before the diagnosis of oHCM. The healthcare costs over time followed the pattern of HCRU. Total HCM-related costs significantly increased in the first year after oHCM diagnosis and then decreased in the second year, although remaining higher than before diagnosis. Total HCM-related costs substantially increased after diagnosis, largely driven by inpatient hospitalization cost and surgical cost.

There are many advantages of using medical and pharmacy claims data for research. Our study provides a comprehensive analysis of resource utilization and cost of illness for patients with oHCM across various care settings and regions in the United States, reflecting a contemporary era of cardiovascular diagnostic imaging and surgical treatments. Claims data are not limited to services provided at single healthcare systems; therefore, capturing data from >50 million lives of commercially insured and Medicare Advantage members is more generalizable to privately insured patients in the United States. Studies using claims data also allow for longitudinal assessment, enabling us to capture economic data over a 7-year period from a diverse sample of patients.

Previously reported oHCM cost analyses that we are aware of used real-world data from the US National Inpatient Sample, and

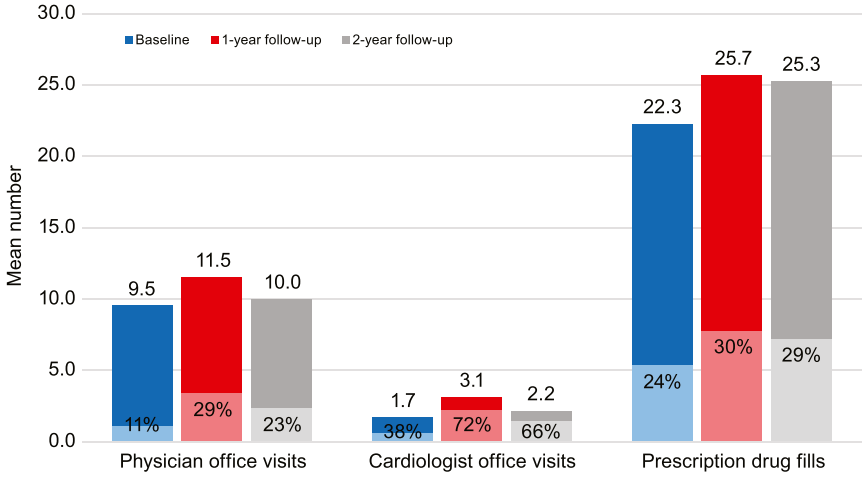

Fig. 1. Healthcare resource utilization.
Lower bars represent proportion of HCM-related utilization. HCM, hypertrophic cardiomyopathy.

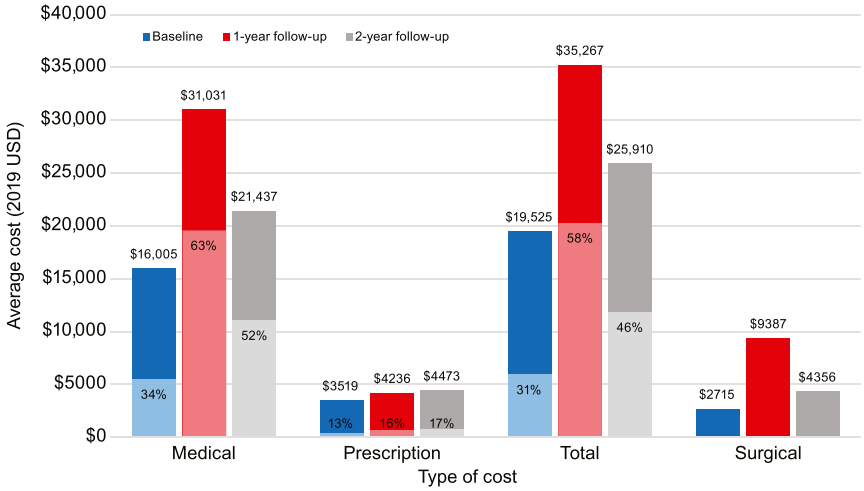

Fig. 2. HCM-related healthcare costs as a proportion of all-cause costs.
HCM, hypertrophic cardiomyopathy.

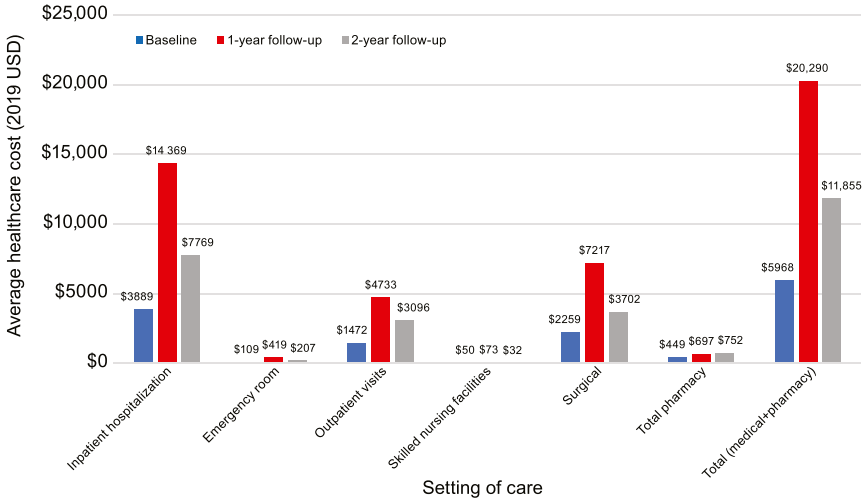

Fig. 3. oHCM-related healthcare costs.
Surgical costs are not mutually exclusive with other categories. Total costs do not include surgical costs. oHCM, obstructive hypertrophic cardiomyopathy.

comparisons with our results are difficult as patients in our cohort were older and had a larger proportion of males compared with the previous studies [7,9]. Older age in our cohort of real-world patients could be a result of delayed diagnosis in the general cardiovascular practice community due to the underrecognized nature of HCM. Additionally, our methods included an index date of the first observed oHCM diagnosis date in commercial health plans and Medicare Advantage over the study period. This may not reflect initial diagnosis age for all patients if they had a historical diagnosis of oHCM prior to 2012 (preindex period) or entered this network due to a change in healthcare coverage at any time during the period from 2012 to 2020. In addition, the National Inpatient Sample has important differences to using a commercial database [7–9]. In particular, the sample is an all-payer database of inpatient admissions and thus can capture a larger set of patients with oHCM that are specific to inpatient resource utilization and costs. This is important for capturing contemporary treatments for oHCM including implantable cardioverter defibrillator procedures and septal reduction therapy. Additionally, the National Inpatient Sample contains data on hospital characteristics including bed size, location (urban vs. rural), and teaching status, which could influence both HCRU and costs of care. However, utilizing a commercial database has major advantages and extends upon previously reported data from the National Inpatient Sample. We were able to quantify costs and HCRU beyond inpatient hospitalizations by including emergency room visits, outpatient visits (total and with cardiologist), diagnostic procedures, skilled nursing facility visits, surgical procedures (in other settings), and pharmacy use. This allowed us to characterize all-cause and disease-related HCRU and costs of care. We also were able to compare the proportion of all-cause HCRU and costs that were related to HCM, highlighting the burden of additional costs of comorbidities for patients with HCM.

In a recent study of patients with oHCM, Jain and colleagues used private sector healthcare claims data from the US IBM MarketScan Commercial and Medicare Supplemental database to assess HCRU and costs of patients with oHCM (symptomatic and asymptomatic) versus matched controls [10]. They found that patients with oHCM incurred significantly greater 1-year total healthcare costs than patients without oHCM ($26,929 ± 77,720 vs. $6808 ± 25,712), including for patients with symptomatic oHCM versus patients without oHCM ($43,586 vs. $6768) [10]. In contrast, patients with asymptomatic oHCM incurred nonsignificant annual 1-year costs versus patients without oHCM ($10,467 vs. $6847) [10]. In comparison with our analysis, Jain and colleagues reported greater mean 1-year total healthcare costs for patients with oHCM ($26,929 vs. $20,290). In terms of HCRU, a higher proportion of patients in our analysis had all-cause inpatient admissions

(32.0% vs. 22.7%) and the annual number of all-cause outpatient visits was higher (35.5 ± 35.4 vs. 20.9 ± 21.0) but the proportion with all-cause emergency room visits was slightly lower (24% vs. 26.7%). Thus, while their source database allowed Jain and colleagues to identify a larger sample of oHCM patients compared to our analysis (N = 11,410 vs. N = 1841) as well as the ability to capture HCRU and costs associated with symptomatic oHCM (chest pain, dyspnea, fatigue, syncope), the results showed a broadly similar pattern to our cohort, identifying substantial increases in HCRU and costs after oHCM diagnosis [10]. Our study extends upon this report by including additional observation periods (pre-oHCM diagnosis and 2-year follow-up) and a broader spectrum of HCRU and cost variables including prescription drug refills and surgical costs for patients with oHCM.

Our data provide new insights into the cost of care for patients with oHCM. In the first year after oHCM diagnosis, HCRU and costs increased, and then decreased in the second year. This presumably reflects the costs associated with initial diagnosis and management of oHCM and the reduction in the second year reflects a disease with relatively low risk of severe cardiovascular adverse events. Our results also highlight the burden of additional comorbidities in patients with oHCM. Of the all-cause total healthcare expenditure, HCM-related costs accounted for 58% in the first year and 46% in the second year, suggesting the remainder is attributable to non-HCM–related resource utilization and costs. The increase in HCM-related total costs was largely driven by inpatient hospitalizations and surgical costs, highlighting the majority of HCM-related costs are attributable to HCM events requiring hospitalization and the need for surgical intervention. Patients in this cohort were not required to have surgery for inclusion and since these costs of HCM-related surgery were lower than previously reported [7–9], we can assume the costs of surgery may not be limited to costly procedures such as septal reduction therapy. HCM-related medication costs were minimal—at about 2% of total healthcare expenditures—reflecting current use of generic drugs that typically have low costs.

This study provides benchmark economic data for management and evaluation for patients with oHCM. Real-world data on cost and resource utilization from a large, diverse medical and pharmacy claims database across the United States reflect the HCM-related and all-cause economic burden for patients with this disease. We also have provided new insights on the additional, substantial cost associated with all-cause and cardiovascular-related comorbidities in patients with oHCM. These results increase our understanding of the disease-related cost of oHCM and may provide decision-makers with important cost data for management considerations. Future research studies should use real-world data to compare the cost-effectiveness of contemporary treatments for oHCM and provide inputs into an economic model forecasting the trends in cost of care in relation to clinical characteristics and predictors of disease progression in HCM.

As with all studies based on claims data, interpretation of our study results is limited to some extent by the inherent limitations of all administrative data, which may be subject to coding biases, inconsistencies, and missing data owing to the nature of collection. All patients included in the study were enrolled in commercial or Medicare Advantage health insurance plans in the United States and the results may not be generalizable to patients with other types of health insurance, to those who are uninsured, or to those outside the United States. Our methods used an index date of the first observed claim with oHCM diagnosis over the study period. Since we were unable to collect data prior to 2012, this may not reflect initial diagnosis age for all patients if they had a historical diagnosis of oHCM. Claims data do not include patient race/ethnicity, which could provide meaningful insights on the effect of race on the ability to access healthcare services in this cohort. A further potential limitation of our analysis is that the data source did not allow us to report HCRU and costs for specific procedures. For example, we quantified total HCM-related diagnostic cost but did not separate cost by specific procedure (echocardiogram, cardiac magnetic resonance imaging, etc.). Similarly, we did not analyze costs associated with specific comorbidities and can only provide assumptions on what additional conditions may be influencing all-cause HCRU and costs. However, the HCRU and costs provided represent a detailed, overall picture of the clinical journey and treatments for patients with oHCM.

5. Conclusion

This analysis of real-world data on cost and resource utilization from a large, diverse medical and pharmacy claims database across the United States shows the HCM-related and all-cause economic burden for patients with oHCM. Costs related to HCM were increased over the 2-year period after oHCM diagnosis, driven mostly by inpatient hospitalizations and surgical costs. Medication use was high, but costs were low, possibly reflecting use of generic multi-indication drugs for oHCM treatment. These results increase our understanding of oHCM-related cost and may aid decision-makers in disease management. Future research studies should use real-world data to compare the cost-effectiveness of contemporary treatments for oHCM.

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Declaration of competing interest

M Maron is a steering committee member at Cytokinetics, Incorporated.

C-C Teng, H Tan, and E Stanek are employees of HealthCore.

M Butzner is an employee of Cytokinetics, Incorporated.

P Sarocco and L Robertson were employees of Cytokinetics, Incorporated at the time the research was conducted.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ahjo.2022.100089.

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