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ORIGINAL ARTICLE

The impact of a community-based heart failure multidisciplinary team clinic on healthcare utilization and costs

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Abstract

Aims Multidisciplinary team (MDT) management in heart failure (HF) is recommended to reduce mortality and HF hospitalization. We investigated whether an MDT in a community-based HF unit (HFU) impacted patients' healthcare utilization (HCU) and costs.

Methods and results A retrospective cohort study was conducted among HF patients who visited at least once in a regional community-based HFU, established for ambulatory specialist care for New York Heart Association Functional Classes III and IV, between January 2012 and August 2019. HCU data were obtained from the health maintenance organization's claims data for 12 months before and after first HFU visit. Multivariable generalized estimating equation models were specified for the annual average change in total healthcare utilization and hospitalization costs. Our cohort consisted of 962 patients, of whom 843 (87.6%) completed at least 12 months of follow-up (Group A) and 119 (12.4%) died within 12 months following their first visit (Group B). Both groups were comparable regarding sex, socio-economic status, Charlson Comorbidity Index, ischaemic heart disease, and/or carotid artery disease. Those who died within 12 months were older and had more hypertension, diabetes, chronic renal disease, and malignancy. There was a significant reduction in the total average annual HCU costs of the entire study population 12 months after the first HFU visit [$12 675 (±17 210) after vs. $13 188 (±15 011) before, $P = 0.014$]. This was driven by a reduction in costs among patients who completed 12 months of follow-up [$11 955 (±17 352) after vs. $13 112 (±15 268) before, $P < 0.001$], whereas an increase in these costs was observed among patients who died during follow-up [$17 774 (±15 292) after vs. $13 728 (±13 093) before, $P = 0.015$]. These opposite trends stem mainly from a decrease [$3540 (±8991) after vs. $4941 (±6806) before, $P < 0.001$] vs. increase [$10 932 (±11 660) after vs. $6733 (±7215) before, $P = 0.002$] in hospitalization costs of these groups, respectively. The multivariable models revealed that patients who died within 12 months following the first visit to the HFU demonstrated a significant increase of 57% in hospitalization costs following their first visit [relative risk (RR) = 1.57, 95% confidence interval (CI): 1.20–2.05, $P = 0.001$], whereas there was a decrease of 34% in the hospitalization costs of patients who completed 12 months of follow-up after their first visit (RR = 0.66, 95% CI: 0.54–0.81, $P < 0.001$). The entire cohort demonstrated 27% decrease in hospitalization costs following their first HFU visit (RR = 0.73, 95% CI: 0.62–0.87, $P < 0.001$).

Conclusions Intensification of therapy by a dedicated MDT significantly reduced healthcare utilization and costs, predominantly due to a decrease in hospitalizations.

Keywords Heart failure; Multidisciplinary team; Healthcare utilization

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Introduction

The worldwide prevalence of heart failure (HF) is estimated to be 26 million and is steadily increasing.[1] In the USA and in Europe, the prevalence is approximately 1–2% of the total population.[2] The prevalence also increases markedly with age, and over 80% of those affected are older than 65.[3] Among those over 80 years old, almost 12% of both men and women have HF.[4] Despite great advances in treatment over the past decades with drugs and devices, mortality remains excessive, and many patients continue to be significantly symptomatic and physically restricted.[5,6]

The cost for HF care is a major economic burden, accounting for about 1–3% of total healthcare expenditure in North America[7] and Western Europe.[8] The greatest proportion of this is from hospitalizations, amounting to 60–70% of total medical costs.[8] HF is the commonest reason for hospitalization in people over 65 years old in economically developed countries[2] of which many are recurrent hospital admissions. Risks for death and rehospitalization are pronounced particularly in the early post-discharge period: about 25% of patients are readmitted within 3 months and about 66% within 1 year.[9] A recent review suggested that the median total annual medical cost for HF in the USA is $24 383, of which hospitalizations account for $15 879 (66%).[10]

A multidisciplinary team (MDT) approach in the management of HF is a key recommendation in recent guidelines, receiving a Class 1A recommendation in the European Society of Cardiology guidelines[11] to reduce mortality and HF hospitalization and a Class 1B recommendation in the American College of Cardiology Foundation/American Heart Association guidelines.[12] No concrete rules have been determined about the composition of the MDT, but most models include a cardiologist/HF specialist, an HF nurse, and other health professionals, such as a pharmacist, dietician, and physiotherapist.[13] In addition, there is no consensus about the form of the care and follow-up provided, whether by telephone, self-care intervention, or in dedicated clinic settings.[13] Meta-analyses and systematic reviews[14–16] have demonstrated varying results in terms of reductions in all-cause mortality, all-cause hospitalization, and HF hospitalization following multidisciplinary management of HF. A study conducted in Jerusalem, Israel, reported a reduction in hospital admissions among New York Heart Association (NYHA) II–IV HF patients treated in a community-based nurse-led HF clinic.[17] However, no data on changes in healthcare utilization (HCU) and costs were presented. In the current study, we investigated whether a community-based HF MDT clinic impacted on all-cause HCU and associated costs of a cohort of patients with advanced HF (NYHA III and IV).

Methods

Study design and setting

Health care in Israel is largely provided and coordinated by four health plans [health maintenance organizations (HMOs)]. All citizens have access to a comprehensive benefits package with low or no co-payment. HCU and associated costs are collected by each of these HMOs. These patient-level data enabled us to provide reliable and comprehensive measures of HCU data for a representative cohort of patients.

A retrospective cohort study was conducted among members of the Southern District of Clalit Health Services (Clalit), the largest HMO in Israel, providing care to more than half of the Israeli population and to over 60% of the Southern District. In January 2012, the Southern District of Clalit established a community-based HF unit (HFU), with the aim of providing ambulatory specialist HF care for patients with advanced HF, emphasizing patients in NYHA Functional Classes III and IV, especially those with recurrent hospitalizations. Patients referred to the HFU are assessed and treated by a dedicated team, including HF cardiologists, HF nurses, and a dietician. As emphasized in guidelines, the education and participation of the patient (and family) in self-care and lifestyle changes are essential and best achieved through close professional guidance and instruction; thus, the specialist HF nurse and dietician provide an indispensable service in this regard. Patients are referred by family practitioners, by hospital departments following admission, or by the hospital cardiology outpatient setting.

As opposed to our hospital-based outpatient HF clinic that deals with more stable patients and lacks the capability of giving intravenous therapy or to follow up patients on a frequent basis, treatment in the HFU includes close follow-up and titration of oral medications, administration of intravenous furosemide and iron where necessary, and referral for further investigation and therapy where deemed indicated (such as pacemakers or other devices, and coronary and other cardiac interventions). Because of the need for frequent follow-up (weekly in many instances and occasionally even more frequently), the poor medical state of the patients (with multiple co-morbidities), and the large doses of diuretics given, patients return home after most visits with a referral for blood tests and drug prescriptions, avoiding the necessity for making an interim appointment with their family practitioner for this purpose. The HFU services do not include home visits.

Study population

The inclusion criteria were patients (i) of the Southern District of Clalit; (ii) eligible during the entire follow-up; (iii) diagnosed with congestive HF (ICD-9 codes 428.xx) with advanced HF, as defined by NYHA Functional Classes III and IV; (iv) who

had first visit between January 2012 and August 2019; and (v) who had ≥2 HFU visits during follow-up. Exclusion criteria were (i) patients with a single visit, as they were deemed inappropriate for follow-up (due to change in diagnosis, inability to continue follow-up, or early death); (ii) patients who died within 1 month after their first visit; and (iii) Clalit employees (because their HCU may be biased because of waived co-payments).

The investigation conforms to the principles outlined in the Declaration of Helsinki. The Clalit's Internal Review Board Committee for Community Medicine approved the study protocol, and participants' informed consent was waived by this committee because it was a secondary analysis of de-identified dataset (Research No. 0078-17-COM1).

Estimation of healthcare utilization and costs

Clalit's patients are covered by generous and quite uniform universal health insurance, providing access to various healthcare services with no or relatively low co-payments. HCU and their related costs analysed in our study included hospitalizations, diagnostic procedures, medications, surgical procedures, emergency department (ED) visits, outpatient specialist visits, home care, and 1 day hospital outpatient care. HCU data were calculated for 12 months before the first HFU visit and 12 months after. The total cost was calculated as the sum of all these estimates. The cost of operating the HFU is incorporated in the cost of visits to the cardiology/HF specialist. We also calculated the cumulative costs of the entire cohort of patients before and after the first HFU visit. Cost estimates were adjusted to September 2020 prices and converted to US dollars (USD) using the September 2020 exchange rate of 3.4 ILS per 1 USD.

During the study period (2012–2019), there have been changes in HF management, including the use of devices [i.e. implantable cardioverter defibrillator (ICD), cardiac resynchronization therapy (CRT), and cardiac resynchronization therapy defibrillator (CRTD)] and improved pharmaceutical therapy [i.e. angiotensin receptor neprilysin inhibitor (ARNI) and sodium–glucose cotransporter-2 inhibitor (SGLT2I)]. In order to account for these changes, we estimated the percentage of patients in our cohort that underwent ICD/CRT/CRTD implantation and filled at least one prescription of ARNI (i.e. sacubitril–valsartan) or SGLT2I (i.e. empagliflozin and/or dapagliflozin with or without metformin), before and after their first HFU visit.

Data analyses

The Wilcoxon matched-pairs test was used to determine within-group differences in HCU before and after first HFU visit. Multivariable generalized estimating equation models assuming log link function and negative binomial distribution were specified to analyse predictors of total HCU and hospitalization costs. The core independent variables were after (vs. before) first HFU visit, study group (12 months of follow-up vs. others), and the interaction between these two variables. The models were adjusted for potential confounders including age, gender, ownership of voluntary supplementary health insurance, the Charlson Comorbidity Index, co-morbidities, number of annual HFU visits, at least one refill of ARNI or SGLT2I, and undergoing ICD/CRT/CRTD implantation. P value <0.05 determined statistical significance in all analyses. Data were analysed using Stata software (Version 15.1, StataCorp LLC, College Station, TX, USA).

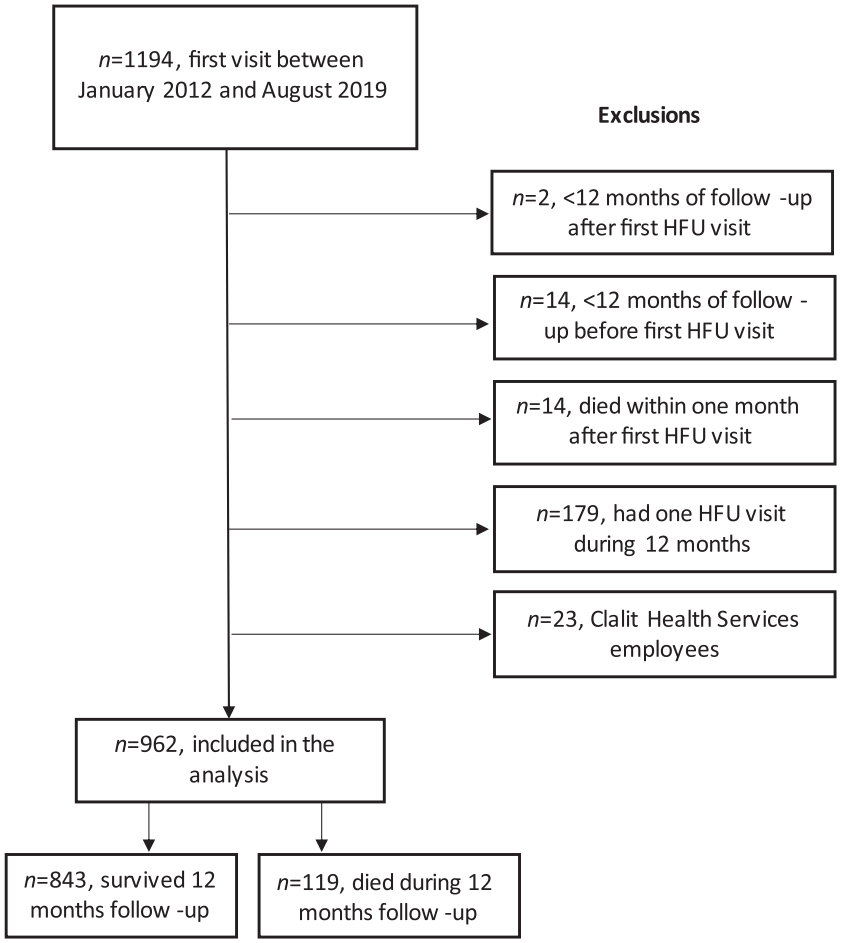
Results

Characteristics of study population

From its inauguration on 1/1/12 to 31/8/19, 1194 patients visited the HFU. Of these, 232 patients were excluded (*Figure 1*) because of <12 months of eligibility after (n = 2) or before (n = 14) their first HFU visit, death within 1 month after their first visit (n = 14), and Clalit employees (n = 23). Additionally, 179 patients with a single HFU visit during follow-up were excluded from the analyses [these patients did not continue follow-up because they had NYHA < III (n = 61), did not have HF (n = 10), had poor compliance (n = 47), had poor mobility (n = 15), were referred to general cardiology follow-up (n = 17), or for other reasons (n = 29)]. Hence, 962 patients were included in the final analyses. The mean age of the study population at the first HFU visit was 72.0 years (±12.5), with 10.3% of patients over the age 85, and 63.9% were male. One-hundred and nineteen patients (12.4%) died during the 12 months following their first visit [with mean (median, inter-quartile range) follow-up period of 188 (173, 144) days], while the remainder (n = 843) completed at least 12 months of follow-up (*Table 1*).

Both groups were comparable with regard to sex (P = 0.406), socio-economic status (P = 0.406), Charlson Comorbidity Index (P = 0.203), prevalence of ischaemic heart disease and/or carotid artery disease (P = 0.129), atrial fibrillation (P = 0.895), obesity (P = 0.980), and chronic pulmonary disease (P = 0.728). However, compared with patients who survived a year of follow-up, those who died during the 12 months following their first visit were older ($P < 0.001$), less likely to be smokers (P = 0.035), or have supplementary health insurance coverage ($P < 0.001$). In addition, a higher prevalence of the following co-morbidities was observed in this group: hyperlipidaemia (P = 0.031), hypertension (P = 0.005), diabetes (P = 0.002), chronic renal disease ($P < 0.001$), and malignancy (P = 0.015).

Figure 1 Flow chart of patients' inclusion/exclusion. HFU, heart failure unit.



Univariable analyses of healthcare utilization in the entire cohort

The annual average number of visits per patient in the HFU was 7.9 (range 2–43). Compared with patients with 12 months of follow-up after their first visit, patients who died during the 12 months had fewer visits to the HFU (6.4 vs. 8.1, $P = 0.001$).

Table 2 presents the annual HCU of the entire study population (including those who did not survive a full year). The data reveal a significant reduction in the total annual average HCU costs after the first HFU visit ($12 675 after vs. $13 188 before, $P = 0.014$). This reduction stemmed predominantly from a decrease in surgical procedures ($4027 after vs. $5179 before, $P = 0.003$) and hospitalization costs ($4454 after vs. $5162 before, $P < 0.001$) due to both a drop in the number of admissions ($P < 0.001$) and a drop in the number of hospitalization days ($P < 0.001$). In addition, although not a major component of HCU costs, a reduction in the costs ($P < 0.001$) and number of visits ($P < 0.001$) to the ED was observed (*Table 2*). On the other hand, there was a significant increase in the average costs for medications ($1213 after vs. $951 before, $P < 0.001$), specialist outpatient costs ($391 after vs. $252 before, $P < 0.001$), and home care costs ($397 after vs. $136 before, $P = 0.029$) and visits ($P = 0.030$) (*Table 2*).

The increase in medication costs stems predominantly from increase in medication for blood and blood-forming organs ($349 after vs. $268 before, $P < 0.001$) and for the cardiovascular system ($191 after vs. $124 before, $P < 0.001$) (Supporting Information, *Table S1*).

The cumulative annual cost of the study cohort was $12 192 923 after the first HFU visit compared with $12 686 818 before this visit, reflecting total annual savings of approximately $500 000.

Univariable analyses of healthcare utilization, by study group

Similar analyses by study groups (*Table 3*) reveal that while a reduction in the average total HCU costs was observed

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Table 1 Characteristics of study population, by study group

Variable	Patients with 12 months of follow-up	Patients who died during 12 months of follow-up	*P* value
n	843	119	
Male (%)	64.4	60.5	0.406[a]
Age[b]	71.4 ± 12.7 (74, 16)	76.4 ± 9.4 (78, 14)	<0.001[c]
Age >85 (%)	9.0	19.3	0.001[a]
Hyperlipidaemia (%)	89.6	95.8	0.031[a]
Hypertension (%)	83.3	93.3	0.005[a]
Diabetes (%)	58.5	73.1	0.002[a]
Smokers (%)	51.5	41.2	0.035[a]
Obesity (%)	59.8	59.7	0.980[a]
Ischaemic heart disease and/or carotid artery disease (%)	78.9	84.9	0.129[a]
Atrial fibrillation (%)	71.2	70.6	0.895[a]
Chronic renal disease (%)	57.4	77.3	<0.001[a]
Chronic pulmonary disease (%)	28.7	30.3	0.728[a]
Malignancy (%)	18.3	27.7	0.015[a]
Charlson Comorbidity Index[b]	7.2 ± 2.9 (7, 4)	7.6 ± 2.6 (8, 3)	0.203[c]
Socio-economic status[b]	4.8 ± 2.0 (5, 2)	4.7 ± 1.9 (4, 2)	0.406[c]
Supplementary health insurance coverage (%)	68.2	42.0	<0.001[a]
Number of annual clinic visits[b]	8.1 ± 6.2 (6, 6)	6.4 ± 5.1 (5, 5)	0.001[c]

[a]χ^2 test.
[b]Values are mean ± standard deviation (median, inter-quartile range).
[c]Mann–Whitney *U* test.

Table 2 Healthcare utilization of study population (*n* = 962), before and after first heart failure unit visit

Variable	Before	After	*P*-value[a]
Total healthcare utilization costs	13 188 ± 15 011 (7405, 14 176)	12 675 ± 17 210 (4973, 12 541)	0.014
Surgical procedure costs	5179 ± 11 228 (0, 3964)	4027 ± 10 414 (0, 0)	0.003
Number of procedures	0.4 ± 0.7 (0, 1)	0.3 ± 0.5 (0, 0)	<0.001
Hospitalization costs	5162 ± 6880 (2768, 7236)	4454 ± 9667 (554, 4428)	<0.001
Number of admissions	2.3 ± 2.3 (2, 2)	1.7 ± 2.6 (1, 2)	<0.001
Number of hospitalization days	9.0 ± 12.1 (5, 12)	8.2 ± 19.5 (1, 8)	<0.001
Medication costs	951 ± 2198 (538, 797)	1213 ± 2801 (770, 1022)	<0.001
Number of prescriptions	116 ± 59 (109, 75)	119 ± 60 (115, 76)	<0.001
Diagnostic procedure costs	503 ± 656 (251, 488)	527 ± 665 (278, 550)	0.506
Number of procedures	5.6 ± 4.5 (4, 6)	6.1 ± 4.8 (5, 5)	0.017
Outpatient specialists' consultation costs	252 ± 210 (193, 225)	391 ± 259 (330, 321)	<0.001
Number of visits	8.2 ± 6.1 (7, 7)	14.4 ± 9.1 (13, 11)	<0.001
Home care costs	136 ± 1687 (0, 0)	397 ± 3090 (0, 0)	0.029
Number of visits	0.1 ± 0.9 (0, 0)	0.5 ± 6.6 (0, 0)	0.030
Emergency department costs	192 ± 341 (27, 228)	153 ± 244 (0, 227)	<0.001
Number of visits	1.0 ± 1.6 (1, 1)	0.8 ± 1.3 (0, 1)	<0.001
Other ambulatory treatment costs	813 ± 4181 (22, 268)	1513 ± 6247 (24, 353)	0.017
Number of treatments	4.7 ± 15.9 (1, 3)	6.4 ± 20.8 (1, 4)	0.195

Values are mean ± standard deviation (median, inter-quartile range). Costs are in September 2020 USD.
[a]Wilcoxon matched-pairs signed-rank test.

among patients who had 12 months of follow-up ($11 955 after vs. $13 112 before, $P < 0.001$), an increase in these costs was observed among patients who died during follow-up ($17 774 after vs. $13 728 before, $P = 0.015$). These opposite trends stem from a decrease ($3540 after vs. $4941 before, $P < 0.001$) vs. increase ($10 932 after vs. $6733 before, $P = 0.002$) in hospitalization costs of these groups, respectively, and an increase ($1272 after vs. $928 before, $P < 0.001$) vs. decrease ($799 after vs. $1116 before, $P < 0.001$) in medication costs of these subgroups, respectively (*Table 3*).

Implementation of changes in heart failure management in the entire cohort

Table 4 presents the percentage of patients who underwent ICD/CRT/CRTD implantation before and after first HFU visit as well as those who filled at least one prescription of ARNI or SGLT2I. This analysis reveals that a higher percentage of patients in our cohort underwent ICD implantation after their first HFU visit compared with before (7.59% vs. 5.30,

Table 3 Annual healthcare utilization costs before and after first heart failure unit visit, by study group

A. Total healthcare utilization costs				
Study group	*n*	Before	After	*P*-value[a]
12 months of follow-up	843	13 112 ± 15 268 (6904, 13 615)	11 955 ± 17 352 (4396, 9630)	<0.001
Died during follow-up	119	13 728 ± 13 093 (9260, 13 911)	17 774 ± 15 292 (13 318, 19 855)	0.015
B. Hospitalization costs				
Study group	*n*	Before	After	*P*-value[a]
12 months of follow-up	843	4941 ± 6806 (2767, 7028)	3540 ± 8991 (553, 3321)	<0.001
Died during follow-up	119	6733 ± 7215 (4981, 8435)	10 932 ± 11 660 (7878, 12 157)	0.002
C. Medication costs				
Study group	*n*	Before	After	*P*-value[a]
12 months of follow-up	843	928 ± 2293 (519, 782)	1272 ± 2957 (811, 1063)	<0.001
Died during follow-up	119	1116 ± 1347 (741, 965)	799 ± 1157 (469, 647)	<0.001

Values are mean ± standard deviation (median, inter-quartile range). Costs are in September 2020 USD.
[a]Wilcoxon matched-pairs signed-rank test.

Table 4 Percentage of patients who underwent procedures or received medications that reflect change in heart failure management, before and after first heart failure unit visit (n = 962)

	Before	After	*P* value[a]
Implantable cardioverter defibrillator	51 (5.30%)	73 (7.59%)	0.041
Cardiac resynchronization therapy	11 (1.14%)	4 (0.42%)	0.070
Cardiac resynchronization therapy with defibrillator	4 (0.42%)	7 (0.73%)	0.364
Angiotensin receptor neprilysin inhibitor (ARNI)	15 (1.56%)	48 (4.99%)	<0.001
Sodium–glucose cotransporter-2 inhibitor (SGLT2I)	24 (2.49%)	41 (4.26%)	0.032

Values are *n* (%).
[a]χ^2 test.

P = 0.040), yet no significant change was observed in the percentage of patients who underwent CRT (P = 0.070) or CRTD implantation (P = 0.364). In addition, a higher percentage of the cohort, after their first HFU visit, filled at least one prescription of ARNI (4.99% vs. 1.56%, $P < 0.001$) and SGLT2I (4.26% vs. 2.49%, P = 0.032).

Multivariable analyses of healthcare utilization in the entire cohort

The multivariable model for the determinants of the average annual change in HCU costs is presented in *Table 5*.

Model I includes an interaction term between the study group and the time variable (after vs. before first HFU visit). This model suggests that patients who died during 12 months following the first visit to the HFU demonstrated a significant increase of 38% in total HCU costs following their first visit [RR = 1.38, 95% confidence interval (CI): 1.15–1.64, $P < 0.001$]. The change in these costs of patients who had 12 months of follow-up after their first visit cannot be derived directly from the results presented in *Table 4*. Following a test of the linear combination of the coefficients of the time variable and the interaction term, a significant decrease of 20% was observed in this group (RR = 0.80, 95% CI: 0.72–0.90, $P < 0.001$). Model II does not include the interaction term and reveals a decrease of 14% in total HCU costs in the entire study population (RR = 0.86, 95% CI: 0.78–0.95, P = 0.004). Both models show that increase in the number of HFU visits during follow-up is associated with higher total HCU costs (RR = 1.02, 95% CI: 1.01–1.02, $P < 0.001$).

The multivariable model for the determinants of the average annual change in hospitalization costs before and after the first HFU visit is presented in *Table 6*.

Model I includes an interaction term between the study group and the time variable. This model reveals that patients who died during 1 year following the first visit to the HFU demonstrated a significant increase of 57% in hospitalization costs following their first visit (RR = 1.57, 95% CI: 1.20–2.05, P = 0.001). However, there was a decrease of 34% in the hospitalization costs of patients who completed 12 months of follow-up after their first visit (RR = 0.66, 95% CI: 0.54–0.81, $P < 0.001$) as derived from a test of the linear combination of the coefficients of the time variable and the interaction term (results not shown in the table). Model II does not include the interaction term and reveals a significant decrease of 27% in hospitalization costs in the entire study population (RR = 0.73, 95% CI: 0.62–0.87, $P < 0.001$). Again, both models

Table 5 Multivariable GEE models[a] of the annual average change in total healthcare utilization costs (n = 1924)

	Model I		Model II	
Variable	Relative risk [95% CI]	*P* value	Relative risk [95% CI]	*P* value
After first visit (vs. before)	1.38 [1.15–1.64]	<0.001	0.86 [0.78–0.95]	0.004
Study group (12 months of follow-up vs. others)	0.99 [0. 84–1.18]	0.940	0.74 [0.64–0.86]	<0.001
After first visit X study group	0.58 [0.47–0.72]	<0.001		
Age (+1 year)	0.99 [0.98–0.99]	<0.001	0.99 [0.98–0.99]	<0.001
Gender (male vs. female)	1.01 [0.88–1.15]	0.937	1.01 [0.88–1.16]	0.914
Number of annual HFU visits (+1)	1.02 [1.01–1.02]	<0.001	1.02 [1.01–1.02]	<0.001
IHD and/or carotid artery disease	1.41 [1.19–1.67]	<0.001	1.41 [1.19–1.67]	<0.001
Diabetes	1.15 [1.02–1.30]	0.027	1.14 [1.01–1.29]	0.029
Obesity	0.89 [0.78–1.00]	0.053	0.89 [0.78–1.00]	0.053
Chronic renal disease	1.59 [1.38–1.84]	<0.001	1.59 [1.38–1.83]	<0.001
Malignancy	1.38 [1.18–1.60]	<0.001	1.38 [1.19–1.60]	<0.001
Undergoing ICD/CRT/CRTD	4.33 [3.91–4.79]	<0.001	4.27 [3.86–4.73]	<0.001
≥1 filled prescription of ARNI	0.67 [0.55–0.82]	<0.001	0.66 [0.54–0.80]	<0.001

ARNI, angiotensin receptor neprilysin inhibitor; CI, confidence interval; CRT, cardiac resynchronization therapy; CRTD, cardiac resynchronization therapy defibrillator; HFU, heart failure unit; ICD, implantable cardioverter defibrillator; IHD, ischaemic heart disease.
[a]Multivariable generalized estimating equation (GEE) model assuming log link function and negative binomial distribution.

Table 6 Multivariable GEE model[a] of the annual average change in hospitalization costs (n = 1924)

	Model I		Model II	
Variable	Relative risk [95% CI]	*P* value	Relative risk [95% CI]	*P* value
After first visit (vs. before)	1.57 [1.20–2.05]	0.001	0.73 [0.62–0.87]	<0.001
Study group (12 months of follow-up vs. others)	0.87 [0.69–1.08]	0.209	0.52 [0.43–0.63]	<0.001
After first visit X study group	0.42 [0.30–0.59]	<0.001		
Supplementary insurance coverage	0.71 [0.59–0.86]	<0.001	0.71 [0.59–0.86]	<0.001
Number of annual clinic visits (+1)	1.03 [1.01–1.04]	<0.001	1.03 [1.01–1.04]	<0.001
IHD and/or carotid artery disease	1.39 [1.07–1.81]	0.014	1.38 [1.07–1.79]	0.013
Chronic renal disease	1.87 [1.53–2.28]	<0.001	1.86 [1.53–2.26]	<0.001
≥1 filled prescription of ARNI	0.45 [0.29–0.70]	<0.001	0.45 [0.29–0.68]	<0.001

ARNI, angiotensin receptor neprilysin inhibitor; CI, confidence interval; IHD, ischaemic heart disease.
[a]Multivariable generalized estimating equation (GEE) model assuming log link function and negative binomial distribution.

reveal that increase in the number of HFU visits during follow-up is associated with higher hospitalization costs (RR = 1.03, 95% CI: 1.01–1.04, $P < 0.001$).

Discussion

We present a study of a single-centre community-based HFU, established to intensify and improve treatment for patients in NYHA Functional Classes III and IV with recurrent hospital admissions. We have demonstrated how a dedicated team increased medication utilization and costs and increased referrals to further specialist ambulatory assessment and care. As a result of this intensification of therapy, there was a major decline in annual costs of hospitalizations (14% reduction) and of visits to the ED (20% reduction), resulting in a 4% reduction in total costs.

Heart failure care creates an enormous economic burden on healthcare systems, and the largest proportion of which is accounted for by hospitalizations, hence the global drive to identify and promote any methods that may contribute to reducing this problem.

Once a patient with HF has been hospitalized, the risks for death and rehospitalization are markedly increased compared with patients with more stable, chronic HF. There is also a considerable increase in costs with advanced NYHA stage, with NYHA Stage IV being the most expensive.[8] Because of the advanced age of most of the patients, together with a wide range of significant co-morbidities, up to 58–64% of all readmissions are unrelated to HF or to cardiovascular causes.[18,19] Commensurate with the advanced NYHA class, the frequent readmissions lead to a pronounced increase in HCU during the final year of life, an observation that has been previously described[20] (unless the patient is referred to palliative or hospice care[21]).

Perhaps the most effective method of managing HF patients in the community and reducing readmissions is via disease management programmes, where an MDT with an expertise in HF management is involved in the assessment and care. The European guidelines for HF management[11] give a general framework for the establishment of multidisciplinary HF clinics and the range of possible professional staff that may be integrated into the team. There is no single model, and there are expected to be variations depending on local emphasis and availability. Our community-based HF unit fits very closely with

the guideline recommendations, firstly in terms of the staff involved (cardiologists, HF specialists, HF specialist nurses, a dietician, and recently, a pharmacist has joined the team). In addition, our day-to day practice is identical to the aims of the MDT (as shown in table 11, page 36 of the guidelines[11]). In addition, there is a very close association between our community-based HF setting and the regional hospital. Three of five HFU physicians work in both sites, and the first author (J. M. W.) is the head of the regional HF services that combine both the hospital and community-based HF settings. This results in an almost ideal model of 'seamless transitions' between the hospital and community.

A systemic review[22] investigating the effectiveness of disease management programmes in patients with HF found that the most consistent effect found in the studies utilizing outpatient clinic visits was a significant reduction in all-cause hospitalization, which was achieved in five of the nine studies. Our results are in alignment with these findings. We showed a significant decrease in HCU costs, an achievement all the more remarkable when considering the fact that healthcare costs soar during the last year of life,[20] and our patients had a substantial mortality rate.

Interestingly, the saving in cost was achieved when analysing the entire group of patients, including those who died during the year of follow-up (who are more 'expensive' to the healthcare system), albeit the saving was more outstanding when analysing only the patients who had full 12 months of follow-up.

Limitations

Our study has several limitations. First, it is a single-centre study with its own individual staff and facilities, and therefore, the results cannot necessarily be extrapolated to different settings, although the treatment guidelines followed are universal. Second, this is a non-randomized study. We did not compare our patients with a similar population continuing with usual care. Instead, patients acted as their own controls before and after starting treatment in our unit. Third, our analysis relied on administrative data that lack information on disease duration, disease severity, or reason of death; thus, we could not adjust the multivariable analysis to this information. Fourth, we have not presented details of treatment given, but all the physicians in the HFU work according to accepted guidelines,[11] and the fact that there was an almost 30% increase in drug costs is, we believe, a reflection of implementation of guideline-directed medical therapy. Fifth, cost estimates of HCU presented in this study may not be generalizable to other healthcare systems, as practice patterns and tariffs may differ. Even so, this limitation does not weaken our analysis because our objective was to analyse the relative change in HCU following first HFU visit, rather than provide an absolute estimation of the cost of illness of this population. Finally, our study focused on 12 months of follow-up, thus ignores long-term effectiveness and cost-savings associated with care in the HFU.

Conclusions and recommendations

We present the results of a single-centre community-based multidisciplinary HF unit, established to improve treatment for patients in NYHA Functional Classes III and IV. As a result of intensification of therapy by a dedicated team, including referrals to ancillary specialist ambulatory assessment and care and increased guideline-based medication prescribing, we observed an improvement in patient care associated with a major decline in costs of HCU, predominantly through a decrease in hospitalizations. Establishment of dedicated community-based units such as ours, as recommended by HF authorities around the globe, should be encouraged and adapted on a more widespread basis. These clinics are expected to contribute to the improvement in quality of care of HF patients and possible decline in hospital admissions and total health care for these patients in many healthcare settings.

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Conflict of interest

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Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1. Annual medication utilization before and after first visit, by pharmacological group (n = 962).

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