Impact of heart failure clinic visit frequency on hospital admission rates

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BACKGROUND: Many heart failure (HF) hospital admissions are avoidable with appropriate surveillance and self-care support; however, HF clinics and clinicians vary in how frequently they see a patient.
OBJECTIVE: To assess the impact of the frequency of HF clinic visits on hospital admission rates.
METHODS: Data from a retrospective cohort of 110 patients enrolled in an HF clinic were reviewed. Demographic, clinical and provider variables were entered into regression models to determine predictors of recall visits and hospital admissions.
RESULTS: HF clinic visit recall frequency was not predictive of hospitalization rates in this particular cohort. The main predictor of all-cause (35.8%; P=0.02), HF (26%; P=0.03) and cardiovascular (29.5%; P=0.03) hospital admissions was the Seattle Heart Failure Model score.
CONCLUSIONS: The frequency of HF clinic visits had no impact on future hospital admissions in this particular cohort of patients with HF. Simplified algorithms or scores to assist clinicians in deciding on the frequency of recall visits are needed.

Key Words: *Clinic visit frequency; Heart failure; Heart failure clinic; Hospitalizations; SHFM score*

There are >5 million individuals in the United States with heart failure (HF), and 500,000 new cases diagnosed annually (1). HF is characterized by a high variable symptom burden, poor quality of life issues, and high morbidity and mortality (2). Admission to a hospital for HF is expensive, with >50% of the total HF health care funding spent on hospital-based care (3). Many HF hospital admissions are avoidable with appropriate treatment, symptom surveillance and self-care support (2). HF clinics (HFCs) are specialized multidisciplinary ambulatory care clinics recommended as best practice for patients with HF (4-6).

There is significant variability within clinical trials that demonstrated the efficacy of HFCs as a management strategy for patients with HF, and within clinical practice (7-10). HFCs have expanded in number (11), but remain a scarce resource; therefore, determining the optimal recall frequency may assist in resource allocation. Patterns of patient recall differ regardless of similarities in patient characteristics such as symptoms measured by New York Heart Association (NYHA) class (2), left ventricular ejection fraction (EF) or other clinical status indicators, including the Seattle Heart Failure Model (SHFM) score (12). The SHFM score has been shown to estimate survival of patients with HF (12). For example, the SHFM score ranges from −1 to 4, with risk for pump failure death predicted at a four-fold higher risk for a score of 1, 15-fold for a score of 2, 38-fold for a score of 3 and 88-fold for a score of 4.

Despite many physiological, comorbid, behavioural and socioeconomic factors being associated with HF hospital admission risk, none are reliably predictive (13-16). An additional factor is clinical vulnerability in the transition period from hospital to discharge home (4,11,17). HFC visit frequency has not been identified as a risk factor for hospitalization, except where lower and higher intensity visit frequencies were compared (18,19). The objective of the present study was to examine whether frequency of visits was related to hospital admission rates for patients attending an HFC. We further assessed which patient demographic and clinical factors were related to the frequency of HFC visits or hospital admissions.

METHODS

Study design

A retrospective cohort study using a health record review of patients enrolled in one HFC was undertaken. The HFC at the Mazankowski Alberta Heart Institute (Edmonton, Alberta), a large tertiary care facility, has collected demographic and clinical data from consecutive patients with HF since 1989. Details regarding this clinic have been previously published (20). The HFC receives referrals from a region of >1.5 million people. This HFC is considered to be a high-intensity clinic as outlined by the HF Disease Management Scoring Instrument (11). Patients enrolled are followed on a continuous long-term basis. Monitoring between HFC visits is achieved via nursing office telephone follow-up on both a planned and ad hoc basis, according to individualized need in response to a patient's health status or a specific clinical requirement.

Ethics approval for the study was obtained from the Health Research Ethics Board, University of Alberta (Edmonton, Alberta).

Study sample

Total enrollment in the HFC was approximately 1000 patients at the time of the health record review. To ensure adequate representation over a sufficiently long duration of time, three years was selected as the minimum duration in the clinic. There were 338 patients identified as attending the HFC for a minimum of three years, from which 110 had HFC visits within the three designated study time intervals (baseline, 18 months, 36 months). These intervals were chosen to provide a temporal prospective for data analysis. The study inclusion criteria were: confirmed HF diagnosis by experienced HFC physicians; enrolled in the HFC for a minimum of three years; any NYHA class; and HFC visits falling within three time intervals over three years (patients who had died or dropped out of the HFC program during this period were excluded due to unavailability of health records).

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TABLE 1
Patient baseline and follow-up characteristics

Clinical parameters	Baseline (n=110)	18 months (n=110)	36 months (n=110)	P
NYHA class*				
1	24 (21.8)	15 (13.6)	18 (16.4)	
2	6 3 (57.3)	69 (62.7)	55 (50.0)	
3	23 (20.9)	26 (23.6)	36 (32.7)	
4	0 (0)	0 (0)	1 (0.9)	**0.006**
Median	2	2	2	
SHFM score†				
–1	23 (20.9)	16 (14.5)	16 (14.5)	
0	57 (51.8)	59 (53.6)	40 (36.4)	
1	26 (23.6)	26 (23.6)	47 (42.7)	
2	3 (2.7)	7 (6.4)	5 (4.5)	
3	0 (0)	2 (1.8)	1 (0.9)	
4	1 (0.9)	0 (0)	1 (0.9)	
Mean ± SD	0.12±0.83	0.27±0.86	0.42±0.90	**<0.0001**
Median	0.00	0.00	0.00	
EF, %‡	**n=106**	**n=110**	**n=110**	
<10	1 (0.9)	0 (0)	0 (0)	
10–15	6 (5.7)	5 (4.5)	6 (5.5)	
15–20	15 (14.2)	9 (8.2)	9 (8.2)	
20–25	10 (9.4)	10 (9.1)	11 (10.0)	
25–30	9 (8.5)	14 (12.7)	8 (7.3)	
30–35	14 (13.2)	15 (13.6)	19 (17.3)	
35–40	11 (10.4)	8 (7.3)	9 (8.2)	
40–45	16 (15.1)	10 (9.1)	9 (8.2)	
45–50	5 (4.7)	6 (14.5)	11 (10.0)	
>50	19 (17.3)	23 (20.9)	28 (25.5)	**0.002**
Median category	30–35	35–40	35–40	

*Data presented as n (%) unless otherwise specified. *New York Heart Association (NYHA) functional class (1 best → 4 worst); †Seattle Heart Failure Model (SHFM) score (–1 best → 4 worst); ‡Left ventricular ejection fraction (EF): the EF portion of the table uses discrete categories – where the occasional value fit two categories, it was assigned to the lower one (ie,15% – coded 10% to 15%)*

TABLE 2
Heart failure clinic (HFC) visit frequency, n=110

HFC visits, n	0–36 months	0–18 months	18–36 months	P
2	0 (0)	11 (10.0)	14 (12.7)	
3	0 (0)	27 (24.5)	35 (31.8)	
4	3 (2.7)	32 (29.1)	33 (30.0)	
5	12 (10.9)	22 (20.0)	15 (13.6)	
6	11 (10.0)	13 (11.8)	6 (5.5)	
7	22 (20.0)	1 (0.9)	5 (4.5)	
8	21 (19.3)	1 (0.9)	2 (1.8)	
9	17 (15.5)	1 (0.9)	0 (0)	
10	7 (6.4)	1 (0.9)	0 (0)	
11	5 (4.5)	0 (0)	0 (0)	
12	7 (6.4)	1 (0.9)	0 (0)	
≥13*	4 (3.6)	0 (0)	0 (0)	
Mean ± SD	8.20±2.85	4.22±1.77	3.98±1.48	
Median	8	4	4	
Range	4–19*	2–12	2–8	0.032

*Data presented as n (%) unless otherwise specified. *Four patients had >12 total HFC visits in 36 months (n=13, n=14, n=17 and n=19, respectively)*

TABLE 3
Hospital admission rates according to admission category (n=110)

Hospitalizations, n	0–36 months	0–18 months	18–36 months	P
Heart failure				
0	93 (84.5)	98 (89.1)	103 (93.6)	
1	11 (10.0)	11 (10.0)	4 (3.6)	
2	4 (3.6)	0 (0)	2 (1.8)	
3	1 (0.9)	0 (0)	1 (0.9)	
4	1 (0.9)	1 (0.9)	0 (0)	
Mean ± SD	0.24±0.65	0.14±0.48	0.10±0.437	
Median	0	0	0	
Range	0–4	0–4	0–3	**0.549**
Rate/year	0.16	0.09	0.07	
Cardiovascular				
0	80 (72.7)	93 (84.5)	94 (85.5)	
1	23 (20.9)	14 (12.7)	14 (12.7)	
2	6 (5.5)	3 (2.7)	2 (1.8)	
3	1 (0.9)	0 (0)	0 (0)	
Mean ± SD	0.35±0.63	0.18±0.45	0.16±0.42	
Median	0	0	0	
Range	0–3	0–2	0–2	**0.735**
Other				
0	71 (64.5)	95 (86.4)	80 (72.7)	
1	26 (23.6)	10 (9.1)	22 (20.0)	
2	7 (6.4)	4 (3.6)	6 (5.5)	
3	4 (3.6)	0 (0)	1 (0.9)	
4	0 (0)	1 (0.9)	1 (0.9)	
5	1 (0.9)	0 (0)	0 (0)	
6	1 (0.9)	0 (0)	0 (0)	
Mean ± SD	0.57±1.03	0.20±0.59	0.37±0.72	
Median	0	0	0	
Range	0–6	0–4	0–4	**0.028**
All-cause				
0	44 (40.0)	73 (66.4)	69 (62.7)	
1	37 (33.6)	23 (20.9)	25 (22.7)	
2	16 (14.5)	11 (10.0)	9 (8.2)	
3	7 (6.4)	1 (0.9)	5 (4.5)	
4	2 (1.8)	1 (0.9)	1 (0.9)	
5	1 (0.9)	1 (0.9)	0 (0)	
6	0 (0)	0 (0)	0 (0)	
7	2 (1.8)	0 (0)	0 (0)	
8	0 (0)	0 (0)	1 (0.9)	
9	0 (0)	0 (0)	0 (0)	
10	1 (0.9)	0 (0)	0 (0)	
Mean ± SD	1.15±1.58	0.52±0.89	0.63±1.14	
Median	0	0	0	
Range	0–10	0–5	0–8	**0.344**

Data presented as n (%) unless otherwise specified

Study protocol

Patient HFC health record data collection: Data from December 31, 2008 to December 31, 2011 were obtained from patient's HFC health records. Variables collected included demographic indicators (baseline), clinical health status indicators (physiological, clinical, laboratory parameters [baseline, 18 months, 36 months]), SHFM score (baseline, 18 months, 36 months), HFC visit frequency (18 months, 36 months) and hospital admissions (all-cause, HF, cardiovascular [CV] and other [18 months, 36 months]). Some laboratory variables included in the SHFM score were missing from patient health records (lymph %, uric acid, total cholesterol, sodium and hemoglobin). These were entered using the patient's available adjacent values, the average cohort value or predicted value based on other variables for each patient. Data at baseline, 18 months and 36 months were collected within a two-month window on either side of the designated time intervals.

TABLE 4
Model A: Predictors of heart failure clinic (HFC) visits (18 to 36 months), n=110

Model	Predictor variable	R^2	$R^{2\Delta}$	b	SE	β	*t*	P
1	Constant			3.617	0.143		25.224	0.000
	ACHA 0–18 months	**0.334**	**0.111**	**0.511**	**0.139**	**0.334**	**3.679**	**0.000**
2	Constant			2.865	0.368		7.792	0.000
	ACHA 0–18 months	**0.390**	**0.041**	**0.460**	**0.140**	**0.300**	**3.291**	**0.001**
	SHFM score baseline			**0.348**	**0.161**	**0.211**	**2.164**	**0.033**
	SHFM Δ score 0–18 months			–0.272	0.201	–0.129	–1.349	0.180
3	Constant			2.949	0.470		6.274	0.000
	ACHA 0–18 months	**0.407**	**0.014**	**0.466**	**0.140**	**0.304**	**30.328**	**0.001**
	SHFM score baseline			0.414	0.210	0.251	1.970	0.051
	SHFM Δ score 0–18 months			–0.199	0.230	–0.095	–0.868	0.387
	NYHA baseline			–0.121	0.288	–0.058	–0.422	0.674
	NYHA Δ score 0–18 months			–0.236	0.301	–0.094	–0.784	0.435
4	Constant			2.442	0.537		4.543	0.000
	ACHA 0–18 months	**0.474**	**0.058**	**0.314**	**0.147**	**0.205**	**2.130**	**0.036**
	SHFM score baseline			0.317	0.208	0.192	1.526	0.130
	SHFM Δ score 0–18 months			–0.174	0.224	–0.083	–0.776	0.440
	NYHA baseline			–0.198	0.285	–0.095	–0.694	0.489
	NYHA Δ score 0–18 months			–0.186	0.295	–0.074	–0.630	0.530
	HFC visits 0–18 months			**0.233**	**0.085**	**0.277**	**2.752**	**0.007**
	Years in HFC			–0.005	0.035	–0.014	–0.156	0.877

Model 1 Overall value of R^2 = 0.111, adjusted R^2 = 0.103, F (1, 108) = 13.535, P=0.000; Model 2 Overall value of R^2 = 0.152, adjusted R^2 = 0.128, F (3, 106) = 6.331, P=0.001; Model 3 Overall value of R^2 = 0.166, adjusted R^2 = 0.126, F (5, 104) = 4.136, P=0.002; Model 4 Overall value of R^2 = 0.224, adjusted R^2 = 0.171, F (7, 102) = 4.212, P=0.000. Bolded rows indicate statistical significance. ACHA All-cause hospital admissions; NYHA New York Heart Association; SHFM Seattle Heart Failure Model

Patient hospitalization data collection: The Alberta Health Services Data Integration and Measurement Reporting repository was accessed to obtain all-cause, HF, CV and other hospital admission data for the specified study time periods.

Data analysis

Descriptive statistics were used to describe demographic and clinical variables, as well as frequency of HFC visits and hospital admissions. To examine change over time for clinical and physiological status indicators, one-way repeated measures ANOVA was used; for HFC visits and hospitalizations, paired *t* tests were used. Unless otherwise stated, variables did not change over time. Change scores were also calculated for NYHA and SHFM scores (the difference between scores from baseline to 18 months, and from 18 to 36 months), to reflect change in patient clinical status over each period. Significant variables using Pearson's r (P≤0.05) were then entered into hierarchical multiple regression models to determine predictors of HFC visits and each category (all-cause, HF, CV, other) of hospital admissions from 18 to 36 months. HFC visits (zero to 18 months) or hospital admissions (zero to 18 months) were first entered, then SHFM score (baseline), SHFM change score, NYHA (baseline) and NYHA change score, followed by years in HFC.

RESULTS

Patient characteristics

The patients' age ranged from 28 to 97 years (median 76.5 years); 75% of patients were ≥65 years of age and 55% were ≥75 years. Men comprised 68.8% of the cohort. Patients attended the HFC from 2.5 to 20.4 years (median 5.3 years). Ischemia was the dominant etiology of HF, comprising 53.6% of patients; 30.9% had diabetes mellitus, 48.2% had atrial fibrillation and 9.1% had chronic obstructive pulmonary disease. These comorbidities did not vary over three years. The majority of patients were in NYHA 1 or 2 (79.1%) at baseline, with only one patient being in NYHA 4 at three years (none at baseline) (Table 1). Most (74.5%) did not have a device implanted at baseline; at 36 months, 36% had an internal cardiac defibrillator, a cardiac resynchronization pacemaker or a combination unit.

Baseline median weight was 84 kg. Mean (± SD) heart rate was 69.1±12.8 beats/min, and mean systolic and diastolic blood pressures were 120.6±19.2 mmHg and 69.6±10.5 mmHg, respectively. Across the three years, there was a small decrease in systolic blood pressure (P=0.05), diastolic blood pressure (P=0.003) and mean arterial pressure (P=0.004). Of the patients, 61% had a QRS width ≤120 ms. EF ranged from 10% to 50%; 82.1% having an EF <50% and 38.7% an EF <30% at baseline, with a modest increase (P=0.002) over three years (Table 1).

Sodium, potassium and hemoglobin values showed little fluctuation over time, with median values of 139 mmol/L, 4.5 mmol/L and 135 g/L, respectively. Creatinine values varied from a median of 1.33 mg/dL to 1.46 mg/dL to 1.41 mg/dL over three years. Estimated glomerular filtration rate ranged from a median of 61.5 mL/min/1.73 m^2 to 54 mL/min/1.73 m^2 from baseline to 36 months.

For the SHFM scores, 96.4% of patients were within the 'less at risk' categories from –1 to 1 at baseline; at three years, 93.6% were at –1 to 1 (corresponding to an estimated mortality of approximately 2% to 11%), resulting in a small increase over this period (P=0.00) (Table 1).

HFC visit frequency

Patients were seen in the HFC four to 19 times over the 36 months. The mean number of visits (zero to 36 months) to the HFC was 8.2±2.9. The majority (75%) of patients had five to nine visits, while only four patients had >12 visits. Mean HFC visits occurred less frequently from the zero to 18 months and 18 to 36 months (4.2±1.8 to 3.9±1.5, respectively). Only 4.5% patients were seen in the HFC >6 times during zero to 18 months and 6.4% patients during 18 to 36 months (Table 2).

Hospital admission rates

The number of total hospitalizations for this cohort was low for all admission categories. For all-cause hospital admissions, 40% of the patients had none for the three-year period, and 55% had between one and three, with a range from zero to 10 hospitalizations. CV hospital admissions ranged from zero to three over three years, with most patients (94%) having zero or one hospitalizations. Eighty-five percent

Table 5
Model B: Predictors of heart failure clinic (HFC) visits (18 to 36 months), n=110

Model	Predictor variable	R^2	$R^{2\Delta}$	b	SE	β	*t*	P
1	Constant			3.768	0.131		28.785	0.000
	HFHA 0–18 months	**0.290**	**0.084**	**0.832**	**0.264**	**0.290**	**3.150**	**0.002**
2	Constant			3.593	0.141		25.407	0.000
	HFHA 0–18 months	**0.407**	**0.082**	**0.811**	**0.256**	**0.282**	**3.168**	**0.002**
	CVHA 0–18 months			**0.865**	**0.270**	**0.285**	**3.210**	**0.002**
	Other HA 0–18 months			0.104	0.209	0.044	0.496	0.621
3	Constant			2.876	0.370		7.781	0.000
	HFHA 0–18 months	**0.450**	**0.037**	**0.669**	**0.262**	**0.223**	**2.551**	**0.012**
	CVHA 0–18 months			**0.883**	**0.267**	**0.291**	**3.302**	**0.001**
	Other HA 0–18 months			0.090	0.206	0.039	0.438	0.662
	SHFM score baseline			**0.326**	**0.161**	**0.197**	**2.027**	**0.045**
	SHFM Δ score 0–18			–0.296	0.199	–0.141	–1.490	0.139
4	Constant			2.929	0.466		6.288	0.000
	HFHA 0–18 months	**0.462**	**0.011**	**0.708**	**0.265**	**0.247**	**2.668**	**0.009**
	CVHA 0–18 months			**0.846**	**0.270**	**0.279**	**3.132**	**0.002**
	Other HA 0–18 months			0.095	0.208	0.041	0.457	0.648
	SHFM score baseline			0.363	0.210	0.220	1.731	0.087
	SHFM Δ score 0–18 months			–0.213	0.229	–0.101	–0.932	0.345
	NYHA baseline			–0.074	0.283	–0.035	–0.260	0.796
	NYHA Δ score 0–18 months			–0.245	0.299	–0.098	–0.819	0.415
5	Constant			2.460	0.539		4.562	0.000
	HFHA 0–18 months	0.499	0.035	0.463	0.291	0.161	1.589	0.115
	CVHA 0–18 months			**0.677**	**0.278**	**0.223**	**2.431**	**0.017**
	Other HA 0–18 months			0.082	0.206	0.035	0.397	0.692
	SHFM score baseline			0.311	0.209	0.189	1.489	0.140
	SHFM Δ score 0–18 months			–0.199	0.226	–0.095	–0.880	0.381
	NYHA baseline			–0.160	0.285	–0.076	–0.562	0.576
	NYHA Δ score 0–18 months			–0.182	0.297	–0.072	–0.611	0.543
	HFC visits 0–18 months			**0.193**	**0.089**	**0.228**	**2.171**	**0.032**
	Years in HFC			0.002	0.035	0.005	0.059	0.953

Model 1 Overall value of R^2 = 0.084, Adjusted R^2 = 0.076, F (1, 108) = 9.924, P=0.002 ; Model 2 Overall value of R^2 = 0.166, Adjusted R2 = 0.142, F (3, 106) = 7.023, P=0.000; Model 3 Overall value of R^2 = 0.202, Adjusted R^2 = 0.164, F (5, 104) = 5.276, P=0.000; Model 4 Overall value of R^2 = 0.213, Adjusted R^2 = 0.160, F (7, 102) = 3.955, P=0.001; Model 5 Overall value of R^2 = 0.249, Adjusted R^2 = 0.181, F (9, 100) = 3.682, P=0.001. Bolded rows indicate statistical significance. CVHA Cardiovascular hospital admissions; HFHA Heart failure hospital admissions; NYHA New York Heart Association; Other HA Other hospital admissions; SHFM Seattle Heart Failure Model

of patients had no HF hospital admissions over the three years, with 10% having one HF hospital admission. Total HF admissions ranged from zero to four. Other hospital admissions ranged from zero to six over the total 36 months, showing an increase over time; the majority of patients (64.5%) having none, with the remaining (34%) having one to three admissions (Table 3).

Factors associated with HFC visits
All-cause hospital admissions (zero to 18 months), along with HFC visits (zero to 18 months), accounted for 47.4% of the variance in HFC visits from 18 to 36 months (Table 4). Baseline SHFM score, SHFM change score, baseline NYHA score, NYHA change score, followed by years in the HFC were not predictors of HFC visits. Additionally, HF, CV and other hospital admissions were further explored (Table 5). CV hospital admissions (zero to 18 months) and HFC visits (zero to 18 months) were predictive of HFC visits from 18 to 36 months, explaining 49.9% of the variance; neither HF hospital admissions (zero to 18 months), or other hospital admissions (zero to 18 months) remained predictors in the final model.

Factors associated with all-cause hospital admissions
Baseline SHFM and NYHA scores were predictors of all-cause hospital admissions (18 to 36 months), explaining 35.8% of the total variance (Table 6). HFC visits (zero to 18 months), SHFM change score, NYHA change score and years in the HFC were not found to be independent predictors of all-cause hospital admissions.

Factors associated with HF hospital admissions
Baseline SHFM score remained the only independent predictor of HF hospital admissions (18 to 36 months), which explained 26% of the total variance (Table 7). HFC visits (zero to 18 months), SHFM change score, baseline NYHA score and NYHA change score were not found to be predictors of HF hospital admissions.

Factors associated with CV hospital admissions
Baseline SHFM and NYHA scores made significant contributions to CV admissions (18 to 36 months), and explained 29.5% of the total variance (Table 8). HFC visits (zero to 18 months), SHFM and NYHA change scores, and CV hospital admissions (zero to 18 months) were not found to be predictors of CV hospital admissions.

Factors associated with other hospital admissions
Hierarchical regression was used to determine predictors of other hospital admissions (Table 9). NYHA score at baseline and other hospital admissions (zero to 18 months) remained predictors of other hospital admissions (18 to 36 months) in the final model, which explained 39.9% of the total variance.

TABLE 6
Predictors of all-cause hospital admissions (ACHA) (18 to 36 months), n=110

Model	Predictor variable	R^2	$R^{2\Delta}$	b	SE	β	*t*	P
1	Constant			0.416	0.304		1.369	0.174
	HFC visits 0–18 months	0.075	0.006	0.052	0.067	0.075	0.777	0.439
2	Constant			0.218	0.382		0.570	0.570
	HFC visits 0–18 months	0.113	0.007	0.033	0.072	0.047	0.460	0.647
	SHFM score baseline			0.124	0.150	0.091	0.828	0.410
	SHFM Δ score 0–18 months			–0.106	0.181	–0.061	–0.586	0.559
3	Constant			0.874	0.437		2.000	0.048
	HFC visits 0–18 months	0.298	0.076	0.058	0.070	0.083	0.826	0.411
	SHFM score baseline			**0.456**	**0.184**	**0.333**	**2.475**	**0.015**
	SHFM Δ score 0–18 months			–0.249	0.199	–0.143	–1.251	0.214
	NYHA baseline			**–0.729**	**0.251**	**–0.420**	**–2.906**	**0.004**
	NYHA Δ score 0–18 months			0.328	0.261	0.158	1.254	0.213
4	Constant			1.052	0.476		2.213	0.029
	HFC visits 0–18 months	0.311	0.008	0.051	0.070	0.073	0.725	0.470
	SHFM score baseline			**0.441**	**0.185**	**0.322**	**2.378**	**0.019**
	SHFM Δ score 0–18 months			–0.256	0.200	–0.147	–1.284	0.202
	NYHA baseline			**–0.695**	**0.254**	**–0.400**	**–2.736**	**0.007**
	NYHA Δ score 0–18 months			0.302	0.263	0.145	1.150	0.253
	Years in HFC			0.029	0.031	–0.091	–0.952	0.343
5	Constant			1.157	0.473		2.447	0.016
	HFC visits 0–18 months	0.358	0.031	–0.001	0.075	–0.001	–0.007	0.994
	SHFM score baseline			**0.433**	**0.183**	**0.316**	**2.366**	**0.020**
	SHFM Δ score 0–18 months			–0.259	0.197	–0.148	–1.313	0.192
	NYHA baseline			**–0.711**	**0.251**	**–0.410**	**–2.834**	**0.006**
	NYHA Δ score 0–18 months			0.305	0.260	0.147	1.176	0.242
	Years in HFC			–0.024	0.031	–0.075	–0.788	0.433
	ACHA 0–18 months			0.248	0.130	0.195	1.912	0.059

Model 1 Overall value of R^2 = 0.006, adjusted R^2 = –0.004, F (1, 108) = 0.604, P=0.439; Model 2 Overall value of R^2 = 0.013, adjusted R^2 = –0.015, F (3, 106) = 0.459, P=0.712; Model 3 Overall value of R^2 = 0.089, adjusted R^2= 0.045, F (5, 104) = 2.032, P=0.080; Model 4 Overall value of R^2 = 0.097, adjusted R^2= 0.044, F (6, 103) = 1.843, P=0.098; Model 5 Overall value of R^2 = 0.128, adjusted R^2= 0.068, F (7, 102) = 2.143, P=0.046. Bolded rows indicate statistical significance. HFC Heart failure clinic; NYHA New York Heart Association; SHFM Seattle Heart Failure Model

DISCUSSION

Factors influencing HFC visit frequency

For clinicians caring for patients with HF, the decision of when to schedule a follow-up appointment remains complex and individualized to patient and other factors. Our study found no impact of HFC visit frequency on hospital admissions for patients with HF. HFC visits were not driven by standardized risk scores such as SHFM score, but rather by past hospitalizations.

The frequency of visits ranged from four to 19 visits over the three-year period and averaged one every 4.5 months. A wider range in terms of visit frequency has been reported, with visits ranging from twice weekly (21), weekly/biweekly (22-24), monthly/bimonthly (18,25,26), every three to four months (27,28), as well as one to two total visits (29-31), and 'individual' or 'as needed' (16,32-34).

The number of all-cause hospital admissions (zero to 18 months) was the main independent predictor for HFC recall visits. HF admissions did not predict HFC visits, nor did any demographic or clinical factors in this cohort. There is no evidence any demographic or clinical parameters contribute to HF clinic frequency of visits (2,14). It is implied that 'individual patient factors' or 'symptom stability' drive frequency of visits, but no specific clinical indicators have been identified (22,24,33,34). In the present study, no association was found among EF, NYHA score, SHFM score or demographic variables with the number of HFC visits. All-cause hospital admissions are perhaps the strongest indicator of chronic illness severity, and may be the predominant driver of frequency of HFC visits. In the Heart Failure Society of America Consensus Statement (35), recent HF hospital admissions and active, multiple comorbidities were identified for patients most likely to benefit from HFC care.

Factors influencing hospital admissions

Hospital admission rates for this cohort were low, with all-cause hospital admissions occurring most frequently. All-cause hospital admissions have varied from 14% to 39% over six months (23,25), 14% to 63% over one year (29,32,34), to 55% to 87% over 18 months to four years (18,19,36). Others reported means include 0.89±0.98 per 100 days (37), and 0.35±0.62 per year (23), while Doughty et al (28) reported an all-cause hospital admission rate of 1.37 per patient year, Pugh et al (24) a rate of 0.15 per month and Mejhert et al (31) 4.4 per patient over 18 months.

In this cohort, 84% of patients had no HF hospital admissions over the three-year period. HF admissions have been reported at a rate of 24% over three months (30), 42% over six months (26), 22% and 6% over one year for new and long-term patients, respectively (38), and 58.7% over four years (19). Others reported means include 0.48 over six months (21), 0.52±0.76 per 100 days (37) and 0.18 over one year (27), while Galatius et al (39) reported 306 HF admissions for 283 patients over two years.

The number of HFC visits in the present cohort was not predictive of hospital admission rates in any category. The baseline SHFM score was predictive of hospital admissions, except for other hospital admissions. For HF hospital admissions, it was the only predictor. In addition to the baseline SHFM score, the baseline NYHA score also contributed to all-cause, CV and other hospital admissions. In the case of other hospital admissions, baseline NYHA was the main predictor. Other studies have revealed NYHA deterioration significant for HF admission risk (2,16). HF comorbidity burden was previously noted as a risk factor for all-cause hospitalization (13,40,41), as were advanced age, weight, EF, blood pressure, heart rate and selected laboratory

TABLE 7
Predictors of heart failure hospital admissions (HFHA) (18 to 36 months), n=110

Model	Predictor variable	R^2	$R^{2\Delta}$	b	SE	β	*t*	P
1	Constant			0.049	0.114		0.428	0.669
	HFC visits 0–18 months	0.046	0.002	0.012	0.025	0.046	0.480	0.632
2	Constant			–0.108	0.141		–0.767	0.445
	HFC visits 0–18 months	0.200	0.038	–0.006	0.027	–0.022	1.222	0.825
	SHFM score baseline			0.109	0.055	0.213	1.968	0.052
	SHFM Δ score 0–18 months			–0.009	0.103	–0.009	–0.091	0.928
3	Constant			0.009	0.167		0.057	0.955
	HFC visits 0–18 months	0.241	0.018	–0.002	0.027	–0.006	–0.064	0.949
	SHFM score baseline			**0.162**	**0.070**	**0.316**	**2.307**	**0.023**
	SHFM Δ score 0–18 months			–0.059	0.076	–0.091	–0.780	0.437
	NYHA baseline			–0.121	0.096	–0.187	1.268	0.208
	NYHA Δ score 0–18 months			0.124	0.100	0.159	1.242	0.217
4	Constant			0.047	0.185		0.256	0.799
	HFC visits 0–18 months	0.260	0.009	0.003	0.029	0.011	0.098	0.922
	SHFM score baseline			**0.163**	**0.072**	**0.318**	**2.277**	**0.025**
	SHFM Δ score 0–18 months			–0.068	0.077	–0.103	–0.878	0.382
	NYHA baseline			–0.112	0.097	–0.173	–1.155	0.251
	NYHA Δ score 0–18 months			0.124	0.102	0.159	1.218	0.226
	Years in HFC			–0.011	0.012	–0.090	–0.904	0.368
	*HFHA 0–18 months			–0.060	0.099	–0.067	–0.603	0.548

Model 1 Overall value of R^2 = 0.002, adjusted R^2 = –0.007, F (1, 108) = 0.230, P=0.632; Model 2 Overall value of R^2 = 0.040, adjusted R^2 = 0.013, F (3, 106) = 1.479, P=0.225; Model 3 Overall value of R^2 = 0.058, adjusted R^2 = 0.013, F (5, 104) = 1.288, P=0.275; Model 4 Overall value of R^2 = 0.068, adjusted R^2 = 0.004, F (7, 102) = 1.055, P=0.398. Bolded rows indicate statistical significance. HFC Heart failure clinic; NYHA New York Heart Association; SHFM Seattle Heart Failure Model

TABLE 8
Predictors of cardiovascular hospital admissions (18 to 36 months), n=110

Model	Predictor variable	R^2	$R^{2\Delta}$	b	SE	β	*t*	p
1	Constant			0.238	0.112		2.134	0.035
	HFC visits 0–18 months	0.069	0.005	–0.018	0.025	–0.069	–0.714	0.477
2	Constant			0.187	0.140		1.342	0.183
	HFC visits 0–18 months	0.139	0.015	–0.025	0.026	–0.098	–0.960	0.339
	SHFM score baseline			0.042	0.055	0.084	0.767	0.445
	SHFM Δ score 0–18 months			0.043	0.066	0.067	0.649	0.518
3	Constant			0.396	0.161		2.460	0.016
	HFC visits 0–18 months	0.292	0.066	–0.017	0.026	–0.067	–0.664	0.508
	SHFM score baseline			**0.151**	**0.068**	**0.301**	**2.230**	**0.028**
	SHFM Δ score 0–18			0.010	0.073	0.016	0.140	0.889
	NYHA baseline			**–0.237**	**0.092**	**–0.372**	**2.565**	**0.012**
	NYHA Δ score 0–18 months			0.065	0.096	0.085	0.677	0.500
4	Constant			0.411	0.176		2.341	0.021
	HFC visits 0–18 months	0.293	0.000	–0.018	0.026	–0.069	–0.680	0.498
	SHFM score baseline			**0.150**	**0.068**	**0.298**	**2.191**	**0.031**
	SHFM Δ score 0–18			0.010	0.074	0.015	0.131	0.896
	NYHA baseline			**–0.234**	**0.094**	**–0.367**	**2.493**	**0.014**
	NYHA Δ score 0–18 months			0.063	0.097	0.082	0.648	0.519
	Years in HFC			–0.003	0.011	–0.022	–0.226	0.822
5	Constant			0.411	0.176		2.328	0.022
	HFC visits 0–18 months	0.295	0.001	–0.020	0.027	–0.079	–0.753	0.453
	SHFM score baseline			**0.151**	**0.069**	**0.301**	**2.199**	**0.030**
	SHFM Δ score 0–18 months			0.006	0.075	0.009	0.077	0.939
	NYHA baseline			**–0.233**	**0.094**	**–0.366**	**2.478**	**0.015**
	NYHA Δ score 0–18 months			0.066	0.098	0.087	0.678	0.500
	Years in HFC			–0.002	0.011	–0.020	–0.206	0.837
	*Cardiovascular admissions 0–18 months			0.035	0.092	0.038	0.378	0.706

Model 1 Overall value of R^2 = 0.005, adjusted R^2 = -0.005, F (1,108) = 0.510, P=0.477; Model 2 Overall value of R^2 = 0.019, adjusted R^2 = -0.008, F (3, 106 = 0.697, P=0.556; Model 3 Overall value of R^2 = 0.085, adjusted R^2 = 0.041, F (5, 104) = 1.943, P=0.093; Model 4 Overall value of R^2 = 0.086, adjusted R^2 = 0.033, F (6, 103) = 1.613, P=0.151; Model 5 Overall value of R^2 = 0.087, adjusted R^2 = 0.025, F (7, 102) = 1.391, P=0.217. Bolded rows indicate statistical significance. HFC Heart failure clinic; NYHA New York Heart Association; SHFM Seattle Heart Failure Model

TABLE 9
Predictors other hospital admissions (18 to 36 months), n=110

Model	Predictor variable	R^2	$R^{2\Delta}$	b	SE	β	*t*	P
1	Constant			0.129	0.190		0.681	0.498
	HFC visits 0–18 months	0.131	0.017	0.058	0.042	0.131	1.377	0.171
2	Constant			0.139	0.237		0.585	0.560
	HFC visits 0–18 months	0.191	0.019	0.064	0.044	0.146	1.440	0.153
	SHFM score baseline			–0.027	0.093	–0.032	–0.292	0.771
	SHFM Δ score 0–18 months			–0.137	0.112	–0.125	1.218	0.226
3	Constant			0.469	0.274		1.710	0.090
	HFC visits 0–18 months	0.297	0.052	0.077	0.044	0.175	1.743	0.084
	SHFM score baseline			0.143	0.116	0.166	1.234	0.220
	SHFM Δ score 0–18			–0.200	0.125	–0.183	–1.600	0.113
	NYHA baseline			**–0.371**	**0.158**	**–0.341**	**2.356**	**0.020**
	NYHA Δ score 0–18 months			0.139	0.164	0.106	0.846	0.400
4	Constant			0.574	0.299		1.922	0.057
	HFC visits 0–18 months	0.399	0.064	0.067	0.043	0.153	1.566	0.120
	SHFM score baseline			0.142	0.113	0.165	1.259	0.211
	SHFM Δ score 0–18			0.010	0.074	0.015	0.131	0.896
	NYHA baseline			**–0.234**	**0.094**	**–0.367**	**2.493**	**0.014**
	NYHA Δ score 0–18 months			–0.204	0.121	–0.187	1.683	0.095
	Years in HFC			–0.020	0.019	–0.097	1.049	0.297
	Other hospital admissions 0–18 months			**0.311**	**0.111**	**0.255**	**2.786**	**0.006**

Model 1 Overall value of R^2 = 0.017, adjusted R^2 = 0.008, F (1, 108) = 1.897, P=0.171; Model 2 Overall value of R^2 = 0.036, adjusted R^2 = 0.009, F (3, 106) = 1.335, P=0.267; Model 3 Overall value of R^2 = 0.088, adjusted R^2 = 0.045, F (5, 104) = 2.017, P=0.082; Model 4 Overall value of R^2 = 0.095, adjusted R^2 = 0.043, F (6, 103) = 1.810, P=0.104; Model 5 Overall value of R^2 = 0.159, adjusted R^2 = 0.102, F (7, 102) = 2.762, P=0.011. Bolded rows indicate statistical significance. HFC Heart failure clinic; NYHA New York Heart Association; SHFM Seattle Heart Failure Model

values for HF admission (13,40,41). None of the above were risk factors for the present cohort. Previous hospital admissions have also been cited as a risk factor for subsequent hospitalization (40), as found in the present study for other hospital admissions.

The SHFM score has been shown to predict HF mortality (12), but has not been used to predict hospital admission. Li et al (42) found that higher SHFM scores reflect a higher level of illness in five domains of health utility. Our results indicate it may be a more reliable predictor of hospital admissions than the NYHA score, even for the present less symptomatic HF cohort. This novel finding is not surprising, given the nature of the variables that compute this composite score. What is notable is that the baseline SHFM score did not predict frequency of HFC visits. If the SHFM score has the potential to identify patients at risk for hospital admission, it may have the potential to be an indicator of HF patients who stand to benefit from increased HFC surveillance.

In the present retrospective cohort, HFC specific recall patterns were not analyzed in detail in terms of interval between clinic visits or timing around important transition periods such as hospital discharge. Intensity and complexity of visits were not explored, nor were HFC telephone follow-up calls. Emergency room visits and contacts with primary care providers were also not available.

An interest has emerged in exploring the intensity and complexity of HFC programs (43), as well as the pattern and timing of patient contact around periods of known risk (4). If the SHFM score can identify HF patients at risk for follow-up, it could potentially be utilized at key intervals to determine the individual 'dose' (43) of HFC surveillance required. Moreover, HF clinic patients who are at lower risk could be seen less frequently, or potentially be discharged from clinic, allowing increased resource access. The SHFM score has additional potential as a tool for standardization of HF clinic care. Last, because the majority of HF patients are not cared for by HFCs, the SHFM score may be an effective tool for primary care providers to identify patients at risk for follow-up, for referral to a HF clinic or to maximize evidence based therapies.

CONCLUSIONS

The present retrospective cohort study found no impact of HFC visit frequency on hospital admissions for HF patients. HFC visits were not driven by risk scores, but rather by all-cause hospitalizations. However, SHFM scores were a predictor of hospitalizations for these HF patients. For HF hospital admissions, it was the sole predictor. For all-cause and CV hospital admissions, NYHA score contributed to the risk, while for other hospital admissions, the NYHA score was the main predictor. Additional study is required to examine the relationship of SHFM scores with hospitalization rates, with the potential to expand the use of this composite scoring tool to HF hospitalization risk stratification, and planning of a more individualized HFC frequency of visit recall.

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