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ORIGINAL ARTICLE
Heart Failure

Heart Failure Management Capability and Exacerbation of Heart Failure

— A 6-Month Prospective Cohort Study —

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Background: In households with older individuals, where a patient is experiencing heart failure (HF), effective cooperation between patients and caregivers is crucial for disease management. However, there is limited evidence regarding the impact of cooperative HF management on the incidence of exacerbation. Therefore, the aim of this 6-month prospective cohort study was to investigate the association between HF management capability and exacerbations.

Methods and Results: The study enrolled outpatients (age ≥65 years) with chronic HF from a cardiology clinic and their caregivers. Self-care capabilities among patients and caregivers were evaluated using the Self-Care of Heart Failure Index (SCHFI) and Caregiver Contribution-SCHFI, respectively. Total scores were calculated using the highest score for each item. During the follow-up period, 31 patients experienced worsening HF. The analysis revealed no significant association between the total HF management score and HF exacerbation among all eligible patients. However, in patients with preserved left ventricular ejection fraction (LVEF), high HF management capability of the family unit was associated with a reduced risk of HF exacerbation, even after adjusting for the severity of HF.

Conclusions: In older patients with HF and preserved LVEF, effective HF management may contribute to a lower risk of exacerbations.

Key Words: Caregivers; Heart; Heart failure

The number of adults being diagnosed with heart failure (HF) is rapidly increasing. HF is characterized by significant symptom burden, poor quality of life (QOL), and premature mortality.[1,2] The prevalence of HF is higher in the elderly,[3] with approximately 50% of patients over 80 years of age experiencing HF.[4] According to estimates, the number of older patients with HF is expected to increase in the future.[1] Compared with younger patients, older patients with HF are at higher risk of HF exacerbation due to multiple comorbidities of chronic diseases and associated rehospitalization.[5–7] Therefore, it is essential to establish solid guidelines and methods to prevent rehospitalization. Although one way to avoid HF exacerbations is to encourage appropriate HF management at home,[2] it can be challenging for the elderly to practice self-management due to multiple comorbid chronic diseases occasionally causing physical and cognitive decline.[7] Given this difficulty for older patients in managing HF independently, recent clinical practice guidelines recommend that caregivers should collaborate with patients to improve their self-management capability.[8,9] However, there is still limited evidence as to whether the ability of patients and caregivers to appropriately manage HF is associated with the incidence of HF exacerbations. In the present study, we defined the novel "family-based HF management capability" as the combination of patient and caregiver HF management capabilities and investigated its relationship with the incidence of HF exacerbations. Clarifying this association would provide practical information for families with older patients with HF, possibly improve the predictive accuracy of worsening HF, and reveal the role of caregivers in keeping HF under control.

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Table 1. Baseline Data of Patients and Primary Caregivers

	Total (n=97)	Family unit HF management score		P value
		Lower (n=47)	Higher (n=50)	
Family unit HF score	61.8 [23–85]	40 [27–58]	80 [73–83]	<0.001
Patients				
Age (years)	81.4 [64.0–88.0]	82.0 [72.0–87.5]	83.0 [78.0–88.5]	0.11
Male sex	53 (54.0)	27 (57.0)	26 (51.0)	0.55
BMI (kg/m^2)	22.3±3.4	22.8±3.4	21.8±3.3	0.13
MMSE (score)	24.5 [22.2–28.0]	26.0 [23.5–30.0]	25.0 [22.0–27.5]	0.09
NYHA functional class				0.04
I/II	80 (82.4)	43 (91.1)	37 (72.6)	
III/IV	18 (18.6)	4 (8.5)	14 (27.5)	
Ischemic disease	21 (21.4)	38 (81.0)	39 (76.5)	0.63
LVEF (%)	55.9 [50.0–65.0]	61.8 [50.6–69.7]	59.9 [40.0–63.7]	0.06
Charlson risk index score	3.7 [2.0–5.0]	3.0 [2.0–5.0]	3.0 [2.0–5.0]	0.7
SHFM score	0.52±0.68	0.27±0.64	0.76±0.64	<0.001
Laboratory data				
BNP (pg/mL)	259 [15–342]	158 [63–315]	232 [131–349]	0.09
Hb (g/dL)	12.7±1.9	13.2±2.1	12.2±1.7	0.02
Sodium (mEq/L)	140 [139–142]	141 [140–142]	140 [138–142]	0.12
Total cholesterol (mg/dL)	167±45.9	174±55.3	161±34.7	0.37
Uric acid (mg/dL)	5.96±1.8	5.9±1.3	6.0±2.1	0.85
Lymphocytes (%)	25.4±8.0	25.8±7.0	25.1±9.0	0.65
Self-care of HF index score	42 [25–56]	35 [25–50]	40 [26–62]	0.15
Caregiver				
Age (years)	66.0 [60–77]	65 [47–94]	66 [44–85]	0.98
Male sex	15 (21.7)	6 (28.6)	9 (18.8)	0.36
MMSE score	29 [28–30]	30 [30–30]	30 [28–30]	0.37
CC-SCHFI score	61.9 [48–75]	44 [20–60]	70 [65–81]	<0.001

Unless indicated otherwise, data are given as the mean±SD, median [interquartile range], or n (%). BMI, body mass index; BNP, B-type natriuretic peptide; CC-SCHFI, caregiver contribution to Self-Care of Heart Failure Index; Hb, hemoglobin; HF, heart failure; LVEF, left ventricular ejection fraction; MMSE, Mini-Mental State Examination; NYHA, New York Heart Association; SHFM, Seattle Heart Failure Model.

Methods

Study Design and Participants

This was a single-center prospective cohort study. The study included 134 outpatients, aged ≥65 years, who visited the Department of Cardiology at Hyogo Medical University Sasayama Medical Center between May 2020 and March 2021 and were diagnosed with chronic HF by a physician. Patients were excluded if they had an acute coronary event within the 3 months prior to study entry,[10] if either the patient or caregiver had a diagnosis of dementia, or if the patient's or caregiver's Mini-Mental State Examination (MMSE) score was <21 points.[11] Patients were followed up by examining their medical records or by telephone for any worsening of HF during the first 6 months of observation.

Written informed consent was obtained from all participants (both patients and caregivers) prior to the study. The study protocol was approved by the Research Ethics Committee of Hyogo University of Medical Science (Approval no. 19048) and was conducted in accordance with the principles of the Declaration of Helsinki.

Data Collection

Patient and Caregiver Characteristics Information on age, sex, height, weight, body mass index, systolic blood pressure, HF etiology, hospitalizations for HF exacerbation in the previous year, HF severity based on New York Heart Association (NYHA) functional class and the Seattle Heart Failure Model (SHFM), medications, device therapy, severity of comorbidities using the Charlson risk index,[10] left ventricular ejection fraction (LVEF), blood biochemical tests (B-type natriuretic peptide [BNP], hemoglobin [Hb], lymphocytes, uric acid, total cholesterol, and sodium) was obtained from the medical records or an interview at study entry. SHFM was derived for each patient from 20 variables including age, sex, weight, NYHA class, LVEF, ischemic etiology of HF, systolic blood pressure, and medications.[11] Caregiver characteristics (age and sex) were obtained from questionnaires. Cognitive impairments of patients and caregivers were measured using the MMSE.

HF Management Capability of the Patient and Caregiver The Self-Care of Heart Failure Index (SCHFI) Japanese version 6.2[12] was used to assess the patients' ability to self-manage HF, and the Caregiver Contribution to SCHFI (CC-SCHFI) Japanese version 1[13] was used to assess the primary caregiver's contribution to HF management. The SCHFI and CC-SCHFI contain similar questions, with 3 sections and 22 items. Section A is disease maintenance frequency, Section B is symptom recognition and coping, and Section C is confidence in HF management. In this study, if the survey of the caregiver could not be conducted on the same day as that of the patient, a separate survey

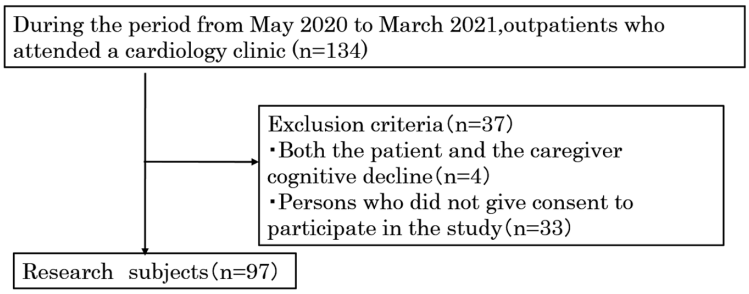

Figure 1. Subject selection flowchart.

was conducted at a later date within 1 week. The SCHFI and CC-SCHFI have separate subscales for self-care maintenance and management behaviors, with varied item response scales. Scores for each subscale are standardized to range from to 0–100, with higher scores indicating better self-care.[13] Although the SCHFI (patient version) asks respondents how often they engage in their own care, the CC-SCHFI (caregiver version) asks how often the respondent recommends that the patient engages in care (or does the behavior for the patient if the patient is unable) on the same items. Based on previous studies, scores for Section B in the SCHFI and CC-SCHFI, representing symptom perception and coping with symptoms, were used in the analysis.[14] The reason for this is that Section B is a scale that reflects the degree to which the patient or primary caregiver follows the guidance and instructions of healthcare professionals and includes many items that are important in preventing exacerbations of HF.[15] In addition to patient management of HF, this study also assessed the capability of the family unit to manage HF. To evaluate the capability of the family unit to manage HF, the higher score on the SCHFI or CC-SCHFI was used as the family unit score for HF management in this study.

Outcomes

The primary outcome of the study was exacerbation of HF and death within 6 months of the start of observation. The definition of exacerbation of HF was based on the 2021 guidelines for the treatment of acute and chronic HF issued by the Japanese Circulation Society (JCS)/Japanese Heart Failure Society (JHFS), and included the following criteria: (1) death or rehospitalization due to exacerbation of HF; (2) increased doses of diuretics or nitrates; (3) initiation of vasodilators, diuretics, or inotropic agents; and (4) an increase in BNP of ≥100 pg/mL.[2,15–17] Outcome surveys were conducted by reviewing medical records or by calling the patient at home.

Statistical Analysis

Data are expressed as the mean±SD or as the median with interquartile range for continuous variables and as numbers and percentages for categorical variables (**Table 1**). Subjects were divided into 2 groups according to the median family unit HF management score, and patient characteristics were compared between the groups using unpaired t-tests or Mann-Whitney U tests for continuous variables and the χ^2 test for categorical variables. Survival curves for HF exacerbation according to management capability were examined using the Kaplan-Meier method, and group differences were evaluated using the log-rank test. Cox proportional hazards regression analysis was used to evaluate independent associations of management capability with HF exacerbation after adjusting for confounders, including SHFM and HF management scores (family unit or patient HF management score). In addition, stratified analyses based on patient characteristics were performed using Cox proportional hazard regression models to evaluate the effect of variable modifications on the associations between HF management score (family unit or patient HF management score) and HF exacerbation. In subgroup testing, patients were divided according to: (1) age (≥75 vs. <75 years); (2) age of the primary caregiver (≥75 vs. <75 years); (3) SHFM (≥1 vs. <1 point); (4) LVEF (≥40% vs. <40%); (5) Charlson risk index (≥3 vs. <3 points); (6) etiology of HF (ischemic vs. non-ischemic); (7) hospitalizations for HF exacerbation in the previous year.

Statistical analyses were performed using EZR version 2.7.1 (R Foundation for Statistical Computing, Vienna, Austria). In all analyses, P<0.05 was considered statistically significant.

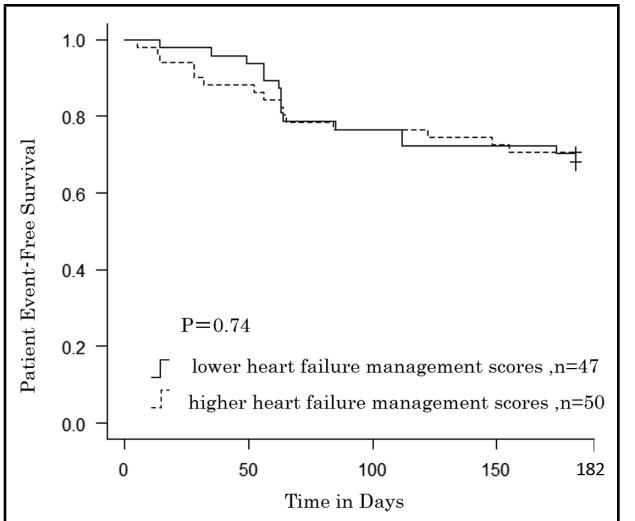

Figure 2. Effect of family unit heart failure management capability on heart failure (HF) exacerbations. During a mean follow-up period of 182±0.4 days, 31 (31.9%) patients experienced HF exacerbation; 10 (10.3%) of these patients were rehospitalized and none died. Fifteen of 50 patients (30.0%) in the high family HF management capability group, and 16 of 47 patients (34.0%) in the low family HF management capability group experienced HF exacerbations.

Table 2. Relationship Between Family HF Management Score and HF Exacerbations

	Crude model		Adjusted model 1[a]		Adjusted model 2[b]	
	HR (95% CI)	P value	HR (95% CI)	P value	HR (95% CI)	P value
Family unit HF management score	0.998 (0.983–1.012)	0.74	0.995 (0.980–1.011)	0.55	0.985 (0.969–1.001)	0.06
Charlson risk index	1.046 (0.933–1.173)	0.44	1.023 (0.909–1.151)	0.71	1.038 (0.919–1.172)	0.55
Rehospitalization due HF exacerbation in past year	1.013 (0.995–1.031)	0.17	2.131 (0.919–1.151)	0.08	1.670 (0.724–3.853)	0.23
SHFM	2.123 (1.197–3.765)	0.01	–	–	2.624 (1.352–5.091)	0.004

[a]Adjusted model 1: the explanatory variables were HF management score, Charlson risk index, and patient readmission to hospital in the past year due to worsening HF. [b]Adjusted model 2: the explanatory variables were HF management score, Charlson risk index, patient readmission to hospital in the past year due to worsening HF, and the SHFM. CI, confidence interval; HR, hazard ratio. Other abbreviations as in Table 1.

Table 3. Relationship Between Patient HF Management Score and HF Exacerbations

	Crude model		Adjusted model 3[a]		Adjusted model 4[b]	
	HR (95% CI)	P value	HR (95% CI)	P value	HR (95% CI)	P value
Patient HF management score	1.013 (0.995–1.031)	0.17	1.021 (1.002–1.040)	0.03	1.021 (1.002–1.040)	0.03
Charlson risk index	1.046 (0.933–1.173)	0.44	0.996 (0.861–1.154)	0.96	1.004 (0.868–1.160)	0.96
Rehospitalization due HF exacerbation in past year	2.100 (0.939–4.697)	0.07	2.385 (0.936–6.077)	0.07	1.672 (0.648–4.314)	0.28
SHFM	2.123 (1.197–3.765)	0.01	–	–	2.093 (1.058–4.143)	0.03

[a]Adjusted model 3: the explanatory variables were HF management score, Charlson risk index, and patient readmission to hospital in the last year due to worsening HF. [b]Adjusted model 4: the explanatory variables were HF management score, Charlson risk index, patient readmission to hospital in the last year due to worsening HF, and the SHFM. Abbreviations as in Tables 1,2.

Results

Patient Characteristics

Of the 134 outpatients, 97 who met the inclusion criteria were included in the analyses (**Figure 1**). Patient and caregiver characteristics, including after stratification according to family unit HF management score, are summarized in **Table 1**. Patients with a higher family unit HF management score had a significantly higher rate of NYHA Class III/IV (P=0.04) than other patients. The group with a higher family unit HF management score had a significantly (P<0.001) higher SHFM score and significantly (P=0.02) lower Hb levels than the other groups. Other baseline characteristics did not significantly differ between the groups.

Family Unit HF Management Scores and HF Exacerbations

The mean observation period in this study was 182±0.4 days. There were no deaths during the observation period, but 31 (31.9%) patients experienced HF exacerbation, of whom 10 (10.3%) were rehospitalized. The incidence rate of HF exacerbations among patients with a higher management capability score was 36 per 100 person-years, compared with 42 per 100 person-years among those with a lower management capability score. Kaplan-Meier survival analysis revealed no significant relationship between family unit HF management score and HF exacerbation (P=0.74; **Figure 2**).

Association Between HF Management Score and HF Exacerbations in Cox Proportional Hazards Regression Analysis

The results of the Cox proportional hazards regression analyses are summarized in **Tables 2**,**3**. In both univariate and multivariate models, there was no significant association between HF management score (family unit or patient HF management score) and HF exacerbations. In the subgroup analyses according to patient characteristics, a significant relationship between family unit HF management score and HF exacerbation was observed in patients with preserved LVEF (**Figure 3**). The implication of this result is that for every 1-point increase in family unit HF management score, the risk of HF exacerbation decreased by 2.3% (95% confidence interval [CI] 0.959–0.996; P=0.02). Conversely, for each 1-point increase in the patient HF management score, the risk of HF exacerbation increased by 2.0% (95% CI 1.020–1.040; P=0.04) for patients aged ≥75 years, by 1.4% (95% CI 1.008–1.110; P=0.02) for patients with an SHFM ≥1, and by 3.6% (95% CI 1.002–1.072; P=0.03) for patients with a Charlson risk index <3; in addition, the risk of ischemic disease increased by 4.8% (95% CI 1.000–1.097; P=0.05) for HF causative disease (**Figure 4**).

Discussion

This prospective cohort study examined the relationship between HF management capability and HF exacerbation in the family unit and included patients with HF and their caregivers. During the 6-month follow-up period, 31.9% of patients experienced worsening HF, and 10.3% were rehospitalized for worsening HF. Analysis of all eligible patients showed no significant association between family unit HF management capability and exacerbation of HF. However, the analysis restricted to the group of patients with preserved LVEF showed that high HF management capability of the family unit contributed to a reduced risk of HF exacerbation, an effect that remained after adjusting for the severity of HF. In contrast, the patient HF manage-

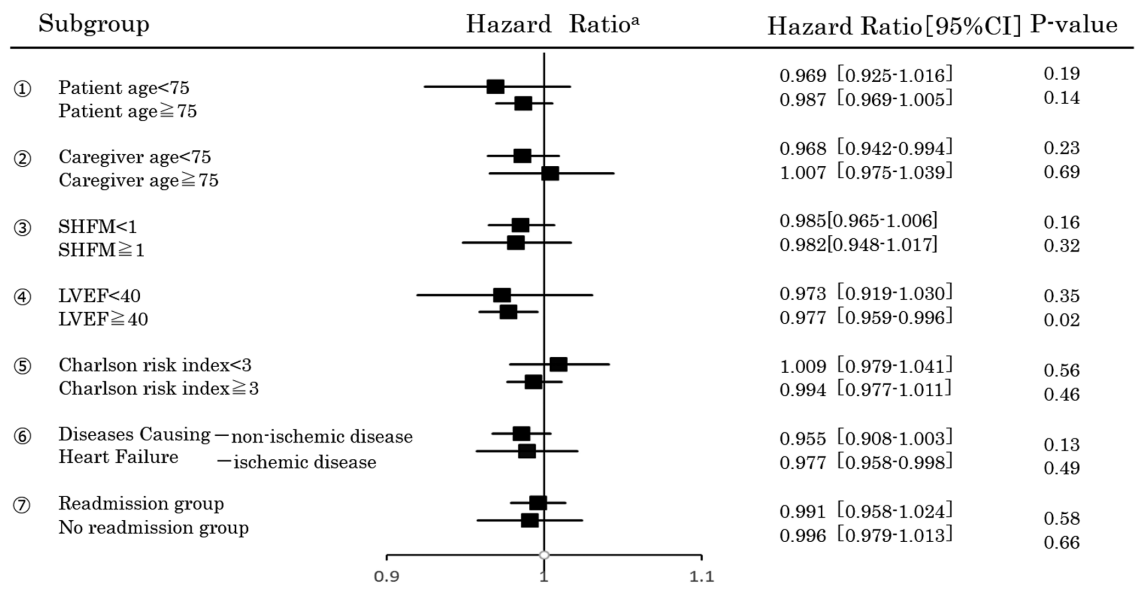

Figure 3. Stratified analysis of family heart failure (HF) management scores and HF exacerbations. [a]All models were populated with Seattle Heart Failure Model (SHFM) and HF management scores as explanatory variables. CI, confidence interval; LVEF, left ventricular ejection fraction.

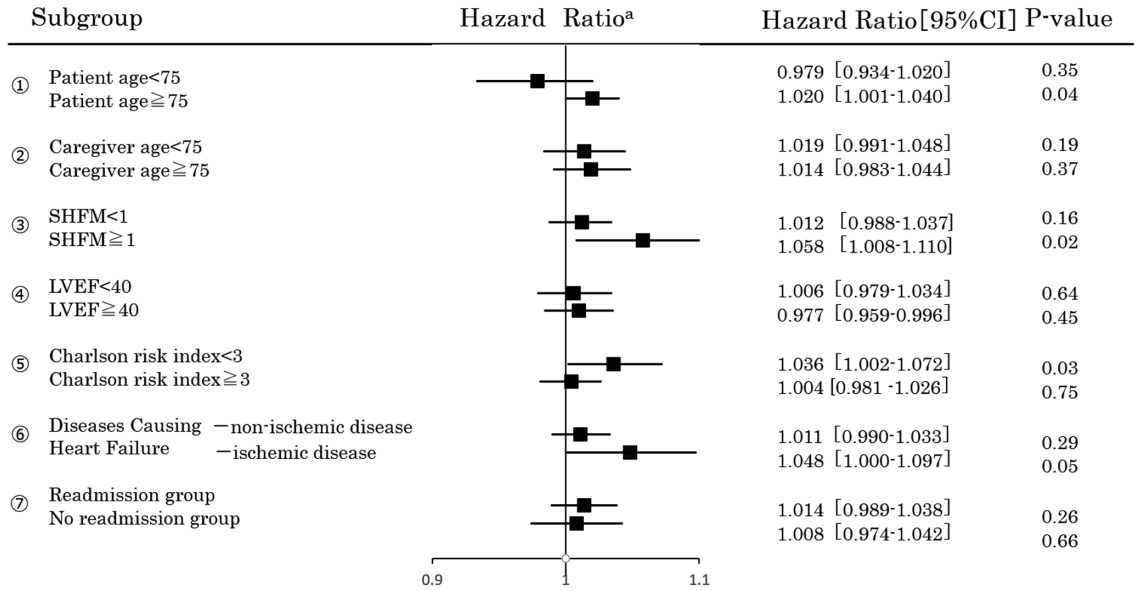

Figure 4. Stratified analysis of patient heart failure (HF) management scores and HF exacerbations. [a]All models were populated with Seattle Heart Failure Model (SHFM) and HF management scores as explanatory variables. CI, confidence interval; LVEF, left ventricular ejection fraction.

ment score was negatively associated with HF exacerbation. This indicates that patient capability to manage their own HF does not necessarily prevent exacerbation of HF. Therefore, a high patient HF management score was not always sufficient, demonstrating the significance of evaluating the family unit score. This study is one of the few prospective cohort studies to examine the relationship between family unit HF management score and HF exacerbation in older patients with HF. To the best of our knowledge, this is the first study to demonstrate the importance of family unit HF management scores in HF patients with preserved LVEF.

Family Unit HF Management Capability

Previous studies have reported that higher HF management skills in the HF patient or primary caregiver were associated with a lower risk of HF exacerbation.[14,15] However, most of these reports are based on non-elderly patients outside of Japan, and the evidence from previous studies cannot be directly applied to Japan, where not only is the pathophysiology of HF different, but the aging of patients and their primary caregivers is also extremely advanced. From clinical experience, it is difficult for elderly HF patients to adequately manage HF by themselves, and active participation of the primary caregiver is necessary. Conversely, given the aging of primary caregivers in Japan, neither the patient nor the primary caregiver should be solely responsible for HF management; rather, they should cooperate with each other, compensating for each other's deficiencies. Therefore, in the present study we decided to use the score for the patient or the primary caregiver, whichever was higher, to calculate the family unit HF management score and to examine the relationship between this ability and HF exacerbation. This method of calculating HF management capacity is based on the idea that either the patient or the primary caregiver should be able to appropriately manage HF, and it is a clinically relevant method that can be used even when the subject has dementia or lives alone. Conversely, if both the patient and the primary caregiver have high or low scores, there is a possibility of under- or overestimating HF capacity. Therefore, it is necessary to study the prognostic ability by increasing the number of subjects and changing the method used to calculate scores.

Impact of Family Unit HF Management on HF Exacerbations

As noted above, previous studies have reported that higher HF management scores in HF patients or caregivers are associated with a lower risk of HF exacerbation,[14,15] but many of these reports are based on younger patients outside of Japan, and therefore the findings cannot be directly applied to Japan, with different HF pathophysiology and older patients and primary caregivers. In fact, most patients in a previous study were in their 60s.[14] In the present study, most patients were in their 80s, a much older age group. Older patients with HF are often not adequately managed for HF because of age-related cognitive decline and cognitive dysfunction, even if they are directed how to manage their HF. It has been suggested that appropriate HF management practice requires not only the ability to understand the need for and methods of HF management, but also the physical ability to perform appropriate management practices and the judgment to identify physical changes.[18] In the present study, the SCHF was scored by interviewing patients to determine how often they implement HF management. Therefore, even if patients actually perform HF management more frequently, the quality of HF management may be lower in older than younger patients due to physical and cognitive decline. Therefore, in the present study, the analysis focusing solely on the patient HF management score showed that the higher the patient HF management score, the higher the risk of HF exacerbation.

Preventive Effect of HF Management on Exacerbation in Patients With Preserved LVEF

Previous studies have reported that 30–50% of older patients with HF have preserved contractility[19–22] and present with diastolic failure.[2,23–26] In older patients with HF with diastolic failure, exacerbations can easily be triggered by faulty eating habits, such as excessive fluid and salt intake, and medication neglect due to cognitive impairment or poor medication adherence.[7,27] The Japanese Cardiac Registry of Heart Failure in Cardiology reported that the prognosis for older patients with HF with preserved contractility but diastolic dysfunction is as poor as that for patients with reduced contractility.[27,28] However, effective therapeutic measures for older patients with HF with preserved contractility have not yet been established.[2,29] In the present study, the analysis was limited to patients with preserved LVEF and confirmed a significant association between higher HF management scores in the family unit and a lower risk of HF exacerbation. Because the present study evaluated the family unit HF management score, we believe that it may have provided insights into the actual HF management situation in real-world clinical practice. In addition, we believe that this study reiterates the importance of the capability of the family unit to manage HF in a group of HF patients with preserved LVEF, allowing for the impact of HF severity. For older patients with HF with preserved LVEF, for whom effective treatment options have not been established, the results of this study may provide important evidence to help establish effective disease management.

Study Limitations

This study has several limitations. First, the study participants were recruited from a single facility in Japan, thereby limiting the generalizability of our findings to a broader international population. Further large-scale studies are needed to confirm the effect in international groups. Second, due to the small sample size, we did not investigate an interaction effect between HF management score (family unit or patient) and patient characteristics such as LVEF in Cox proportional hazards regression model analysis. Therefore, it is still unclear whether the effects of HF management score on HF exacerbations differ between subgroups. Third, the effect of season on HF exacerbations was not considered because the baseline data of the study participants were collected at different times. Fourth, because this was an observational study, it is still unclear whether teaching older patients and their caregivers will improve their ability to manage HF and prevent HF exacerbations. Therefore, future intervention studies are needed.

Conclusions

In older patients with HF, there was no significant association between family unit HF management capability and HF exacerbation. However, when the target population was restricted to those with preserved LVEF, high family unit capability in HF management potentially contributed to a reduced risk of HF exacerbation.

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Disclosures

The authors declare no conflicting financial interests.

IRB Information

This study was conducted with the approval of the Ethics Review Committee of Hyogo Medical University (Approval no. 19048).

Data Availability

Due to the nature of this research, the participants did not agree for their data to be shared publicly, so supporting data are not available.

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