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Hospital-acquired disability in older heart failure patients decreases independence and increases difficulties in activities of daily living

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Abstract

Aims: The aim of this study was to clarify whether worsening of independence in activities of daily living (ADL) and also difficulties in ADL are triggered by hospitalization in older patients with heart failure (HF) and whether difficulties in ADL can predict readmission for HF regardless of independence in ADL in these patients.

Methods and results: We enrolled 241 HF patients in the present multi-institutional, prospective, observational study. The patients were divided according to age into the non-older patient group (<75 years, n=137) and the older patient group ($\geq$ 75 years, n=104). The Katz index and the Performance Measure for Activities of Daily Living-8 (PMADL-8) were used to evaluate independence and difficulties in ADL, respectively. The endpoint of this study was rehospitalization for HF. Independence as indicated by the Katz index at discharge was significantly lower than that before admission only in the older patient group, and the value of the PMADL-8 at discharge was significantly higher than that before admission ($P<0.001$). In all patients, after adjusting for the Katz index and other variables, PMADL-8 score was a significant predictor of rehospitalization for HF (hazard ratio 1.50; 95% confidence interval 1.07 to 2.13; $P=0.021$).

Conclusions: Worsening of both independence and difficulties in ADL was triggered by hospitalization in older HF patients, and difficulties in ADL were relevant factors for risk of rehospitalization regardless of independence in ADL. These findings indicate the importance of preventing not only decreased independence but also increased difficulties in ADL during and after hospitalization.

Key words: Activities of daily living, older patients, heart failure, hospital-acquired disability

Introduction

Heart failure (HF) is a leading cause of death,¹ and its prevalence increases with aging.^{2,3} Due to aging of the population, the number of older patients with HF has been increasing yearly in Europe, Asia, and other parts of the world.^{2,4} A previous study reported that not only exercise capacity⁵ but also physical function, e.g., muscle strength^{6,7} and balance function,⁸ are decreased in older HF patients. Weakness in physical function can cause decreased independence in activities of daily living (ADL) in older patients,⁹ and several studies have shown that decreased independence in ADL worsens with aging in HF patients.^{10,11} This independence in ADL is defined as the ability of patients to perform basic activities such as toileting, walking, bathing, and eating on their own, regardless of whether they experience difficulties during these activities. Furthermore, impairment of these ADL is associated with readmission for HF and mortality.^{10,11} Because life prognosis gradually worsens with repeat readmissions for HF,¹² we need to carefully evaluate and prevent impairment in these ADL to decrease readmission for HF in older patients. Especially, hospital-acquired disability, i.e., decreased independence in ADL triggered by hospitalization, has become a recent common problem in older patients with and without HF^{13,14} because decreased independence in ADL can cause an increase in the risk of falls and a decrease in the rate

of returning home.^{15,16} Thus, it is important to prevent decreased independence in ADL in older HF patients during hospitalization through rehabilitation, which has the potential to improve physical function, decrease the risk of falls, and increase the rate of returning home.^{17,18} Meanwhile, older HF patients are not only experiencing decreased independence in ADL^{10,11} but also worsening difficulties in ADL due to fatigue and breathlessness,^{19,20} which are related with readmission for HF and mortality.^{21,22} These difficulties in ADL are defined as whether patients feel difficulty in various activities, such as walking, bathing, climbing stairs, going uphill, getting in and out of a car, regardless of whether they are able to perform these activities on their own. Worsening of these difficulties in ADL could cause a decrease in their daily physical activity²³ even if they are independent in ADL, and lower daily physical activity relates to a poor prognosis.²⁴ Thus, we need to evaluate not only independence in ADL but also difficulties in ADL. However, it is unclear whether worsening of independence in ADL and difficulties in ADL are triggered by hospitalization in older HF patients even if receiving cardiac rehabilitation (CR) or whether difficulties in ADL can predict readmission for HF regardless of independence in ADL. Thus, a care plan to evaluate and prevent impairment in ADL during hospitalization remains to be established for older HF patients. The aim of this study was to clarify whether worsening of both

independence in ADL and difficulties in ADL is triggered by hospitalization in older HF patients even if they were receiving CR and whether difficulties in ADL can predict readmission for HF regardless of independence in ADL.

Methods

Study design and patients

This was a multi-institutional, prospective, observational study. Data collection was conducted between May 2016 and December 2018 in three acute-care hospitals located in Kawasaki, Japan (1175 beds); Yokohama, Japan (518 beds); and Kawasaki, Japan (138 beds). All three hospitals offer CR services. Patients hospitalized due to acute decompensated HF who were prescribed CR during hospitalization and could walk independently at home before hospital admission were included. CR was prescribed according the Japanese guidelines for rehabilitation in patients with cardiovascular disease²⁵ in all three hospitals. The diagnosis of HF was defined according to the Framingham criteria.²⁶ Exclusion criteria were the presence of complex arrhythmia or unstable angina pectoris; New York Heart Association (NYHA) functional Class IV in the stable phase before hospital admission; severe dementia; hemodialysis; and difficulty in writing (e.g., due to visual impairment). In total, 284 patients with acute

decompensated HF met the eligibility criteria and agreed to participate in our study. Of them, 43 found to have missing data were excluded. Finally, 241 patients were enrolled in this study (Figure 1). The patients were divided according to age into the non-older patient group (<75 years) and the older patient group (≥ 75 years) because in Japan, the definition of an older person has recently been revised to being of age 75 years or older. Thus, we defined an “older patient” as one 75 years old or older.²⁷ All patients were enrolled at the start of walking during hospitalization. Because it was difficult to obtain consent for the study immediately after hospitalization due to the unstable condition of some of the patients, consent for study participation was obtained at the start of walking during hospitalization in all patients when the patient’s condition had stabilized. All patients were and followed up for 1 year from hospital discharge.

The study protocol conformed with the principles outlined in the Declaration of Helsinki. The present study was approved by the Ethics Committee of St. Marianna University School of Medicine for its conduction in St. Marianna University School of Medicine Yokohama City Seibu Hospital, St. Marianna University School of Medicine Hospital, and St. Marianna University School of Medicine Toyoko Hospital (Protocol No. 3236; approval date: 16 May 2016). Signed informed consent for this study was

obtained at the start of walking during hospitalization in the rehabilitation room from all patients before enrolling them in the study.

Cardiac rehabilitation during hospitalization

All patients received CR during hospitalization consisting of 20–60-min sessions 5 times/week by a physiotherapist.⁷ According to the guidelines²⁵ and statements,³³ during the first few days in which the patients with acute decompensated HF were clinically unstable, sitting exercise, mild resistance training ($\leq 30\%$ of 1 repetition maximum or rate of perceived exertion <12), and ambulation exercise at a comfortable walking speed were conducted at bedside for 20 min. After the patients' clinical condition stabilized, ambulation exercise, moderate resistance training (30–40% of 1 repetition maximum or rate of perceived exertion <12 –13), and aerobic exercise by cycle ergometer or treadmill were conducted in the CR room for 60 min.

Data collection and instruments

Age, sex, body mass index (BMI) at hospital discharge, NYHA functional classification, American Heart Association/American College of Cardiology (AHA/ACC) HF classification before hospital admission, number hospital admissions

for HF, HF etiology, comorbidities, acute-phase treatment, medications (renin-angiotensin system [RAS] inhibitor and beta-blocker), time between admission and starting to walk, and length of hospitalization were evaluated from patient medical records. Maximum brain natriuretic peptide (BNP) or N-terminal (NT)-proBNP, estimated glomerular filtration rate (eGFR), and hemoglobin at hospital discharge were measured in blood samples obtained during hospitalization. NT-proBNP and BNP were converted into log BNP according to a previous study.²⁸ Left ventricular ejection fraction (LVEF) was determined echocardiographically by a physician at hospital discharge using a modified Simpson's method and used as the index of left ventricular systolic function. The Mini Nutritional Assessment-Short Form (MNA-SF)²⁹ was used to evaluate nutritional status in the stable phase, defined as the time before hospitalization when the patient's HF had been stable. The Mini Mental State Examination (MMSE)³⁰ was used to evaluate cognition function at hospital discharge. We also investigated patient participation in outpatient CR after hospital discharge.

The Katz index³¹ was used to evaluate independence of ADL in this study. The Katz index is one of the appropriate scales used to assess the ability of patients to perform ADL independently, and its reliability has been assured.³² It has been widely used for the evaluation of ADL in patients regardless of their medical condition. The

index evaluates six basic functional tasks: bathing, dressing, toileting, transferring, bowel & bladder control, and feeding. It presents items in a hierarchy of severity or difficulty of performing each task. Independence and dependence of each item is scored on a dichotomous scale. Total score is in the range of A to G, where a score of A represents an independent patient and G a very dependent one. All patients were evaluated with the Katz index during the stable phase before hospital admission and at hospital discharge. Determination of the Katz index during the stable phase before hospital admission was based on responses retrospectively provided by the patient or the patient's family at the time of enrollment.

The Performance Measure for Activities of Daily Living-8 (PMADL-8)^{7,19} was used to evaluate difficulties in ADL. The PMADL-8 contains measurement items whose reliability to assess difficulties in ADL has also been assured.¹⁹ The PMADL-8 is a self-administered, disease-specific measure of difficulties in ADL for HF patients. The scale comprises 8 items (i.e., getting up and off from the floor without aids, washing your body and hair, going up a flight of stairs without a handrail, vacuuming your room, pulling and closing a heavy sliding door, getting into and out of a car, walking at the same speed with someone of the same age, and walking up a slight slope for 10 min) that assess the difficulty in performing specified daily physical activities using a 4-

category response scale, where 1 = very easy; 2 = somewhat easy; 3 = somewhat hard; and 4 = very hard.). Scores range from 8 to 32, with higher scores reflecting more severe difficulties in ADL. All patients were evaluated with the PMADL-8 during the stable phase before hospital admission and at hospital discharge. Responses to the PMADL-8 during the stable phase before hospital admission were retrospectively reported by the patient at the time of enrollment.

Endpoint

The study endpoint was cardiac events and rehospitalization for HF during 1-year follow-up from hospital discharge. We obtained endpoint information by tracking medical records in each hospital. All patients could be followed up for 1 year from hospital discharge. Cardiac events were defined as all cardiac deaths and rehospitalizations for cardiovascular-related events. Time to endpoint was calculated as the number of days from hospital discharge to the date of the event.

Statistical analysis

Results are expressed as mean $\pm$ SD or median [interquartile range]. Differences in patient clinical characteristics between the non-older patient group and older patient

group were analyzed using the unpaired t -test, Mann-Whitney U test, and χ^2 test.

Correlation between the PMADL-8 and the Katz index in all patients was analyzed using the Kendall rank correlation coefficient. The change in Katz index between the stable phase before hospital admission and at hospital discharge in each group was analyzed using the Wilcoxon signed-rank test. The change in PMADL-8 between these same timepoints in each group was analyzed using the paired t -test. Cox regression analyses were performed to examine that the effect on prognosis of difficulties in ADL at hospital discharge. In this analysis, we constructed three predictive models using pre-existing prognostic factors: model 1 used age, sex, and BMI as adjusting variables; model 2 included Model 1 variables and the Katz index; and model 3 included Model 2 variables plus LVEF <40%, length of hospitalization, times of admission for HF, RAS inhibitor, beta-blocker, eGFR at discharge, log BNP, hemoglobin at discharge, MNA-SF in the stable phase, MMSE at discharge, and outpatient rehabilitation. $P < 0.05$ was considered to indicate statistical significance. All statistical analyses were performed with JMP® Pro 15 (SAS Institute Inc., Cary, NC).

Results

The non-older patient group included 137 patients, and the older patient group included 104 patients (Figure 1). Table 1 shows the clinical characteristics of all study patients and the patients by group. Significant differences between the non-older patient group and older patient group were observed in male sex ($P=0.002$) and in LVEF, times of admission for HF, HF etiology, RAS inhibitor treatment, beta-blocker treatment, and MNA-SF score in the stable phase (all, $P<0.001$). Patient BMI, eGFR, hemoglobin, and MMSE, all measured at discharge, were significantly lower in the older patient group versus the non-older patient group (all, $P<0.001$). Length of hospitalization was significantly shorter in the older patient group versus the non-older patient group (18.5 [13.0, 25.8] vs. 21.0 [15.5, 26.0] days, $P=0.049$). For all patients, the length of hospitalization was 20.0 [15.0, 26.0] days, and there was a significant correlation between the PMADL-8 and Katz index in the stable phase before admission ($\tau=0.24$, $P<0.001$) and between the PMADL-8 and Katz index at hospital discharge ($\tau=0.34$, $P<0.001$).

Figure 2 shows the change in Katz index between the stable phase before admission and hospital discharge in all patients and each group. Independence at discharge as indicated by the Katz index was significantly lower than that before admission both for all patients ($P<0.001$) (Figure 2a) and specifically for the older patient group ($P<0.001$)

(Figure 2b). Meanwhile, there was no significant difference in the Katz index between independence at discharge and that before admission in the non-older patient group ($P=0.083$) (Figure 2c).

Figure 3 shows the change in PMADL-8 between the stable phase before admission and hospital discharge in all patients and each group. The PMADL-8 score at discharge was significantly higher than that before admission both in all patients (discharge: 18.6 ± 5.5 points vs. before admission: 17.2 ± 6.1 points, $P<0.001$) (Figure 3a) and in the older patient group (discharge: 21.3 ± 4.9 points vs. before admission: 18.3 ± 6.3 points, $P<0.001$) (Figure 3c). Meanwhile, there was no significant difference between the PMADL-8 score at the two time points in the non-older patient group (discharge: 16.5 ± 5.1 points vs. before admission: 15.8 ± 5.6 points, $P=0.179$) (Figure 3b).

As indicated by the Katz index, among all patients, 30 (12.4%) had a decrease of independence triggered by hospitalization (i.e., the Katz index changed from A to B). In the 211 patients (87.6%) who showed no decrease of independence triggered by hospitalization, the PMADL-8 score at discharge was significantly higher than that before admission (discharge: 17.9 ± 5.2 points vs. before admission: 16.3 ± 5.7 points, $P<0.001$). Among the older patient group, 27 patients (26.1%) showed decreased independence triggered by hospitalization. In the 77 patients in the older patient group

(74.0%) who showed no decrease of independence triggered by hospitalization, the PMADL-8 score at discharge was significantly higher than that before admission (discharge: 20.3 ± 4.6 points vs. before admission: 17.4 ± 5.9 points, $P < 0.001$). In the non-older patient group, only 3 patients (2.2%) showed decreased independence triggered by hospitalization. In the 134 non-older patients (97.8%) who showed no decrease of independence triggered by hospitalization, there was no significant difference between the PMADL-8 score at discharge and that before admission (discharge: 16.5 ± 5.1 points vs. before admission 15.6 ± 5.5 points, $P = 0.074$).

Nine cardiac deaths (4 patients in the non-older patient group, 5 patients in the older patient group) and 55 rehospitalizations for HF occurred during the 1-year follow-up (6 of the rehospitalized patients suffered cardiac death during this time). Tables 2 and 3 present the results of univariate and multivariate Cox regression analyses for cardiac events and rehospitalization for HF in all patients. In the univariate analysis, PMADL-8 was a significant predictor of cardiac events and rehospitalization for HF (hazard ratio [HR] 1.44; 95% confidence interval [CI] 1.13 to 1.82; $P = 0.003$ and HR 1.46; 95% CI 1.15 to 1.87; $P = 0.002$, respectively). After adjusting for age, sex, and BMI (model 1), PMADL-8 was a significant predictor of cardiac events and rehospitalization for HF (HR 1.41; 95% CI 1.07 to 1.86; $P = 0.014$ and HR 1.44; 95% CI

1.09 to 1.92; $P=0.011$, respectively). Furthermore, PMADL-8 remained a predictor of cardiac events and rehospitalization for HF even after adjusting for variables included in model 1 plus Katz index (HR 1.58; 95% CI 1.17 to 2.15; $P=0.003$ and HR 1.61; 95% CI 1.18 to 2.21; $P=0.003$, respectively) (model 2) and for variables included in model 2 plus the other factors mentioned earlier (HR 1.42; 95% CI 1.01 to 2.01; $P=0.042$ and HR 1.50; 95% CI 1.07 to 2.13; $P=0.021$, respectively) (model 3).

Discussion

The present study found that hospitalization triggered worsening of both independence in ADL and difficulties in ADL in the older HF patients. Contrastingly, hospitalization did not trigger worsening of either factor in the non-older patients. However, in all patients, difficulties in ADL were a predictor for readmission for HF and cardiac events regardless of the degree of independence in ADL and other clinical characteristics.

One previous study reported that hospitalization triggers worsening of independence in ADL in one in three older patients,¹³ and another study reported a similar finding in 33% of older patients with cardiovascular disease that included HF patients.³⁴ The study design of this previous study³⁴ is similar to our study because it

was a prospective cohort study that used the Katz index to assess independence in ADL and included patients aged ≥ 75 years. In the present study, 26% of the older patient group had decreased independence in ADL triggered by hospitalization, indicating a ratio of decreased independence in ADL slightly lower than that in the previous study.³⁴ Thus, we consider the frequency of hospital-acquired disability in independence in ADL in the present study to be reasonable. Incidentally, the length of hospitalization was approximately 19 days in the present study. In Japan, because comprehensive early recovery-phase CR is conducted during hospitalization before patients return to society, a previous study reported that the typical patient length of stay in the hospital was approximately 20 days,³⁵ which is longer than that in the previous study³⁴ and in Europe and the USA.³⁶ Thus, the patient length of stay in this study was appropriate for Japan. Despite the longer length of hospitalization in the present versus previous study,³⁴ the ratio of patients with decreased independence in ADL in the present study was slightly lower than that in the previous study.³⁴ All patients in the present study had received CR based on the published guidelines²⁵ and statements,³³ whereas in the previous study,³⁴ it was unclear whether the study population received CR during hospitalization. As with independence in ADL, despite receiving CR during hospitalization in the present study, the older HF patients experienced difficulties in ADL that were worsened by

hospitalization. Furthermore, worsening difficulties in ADL are thought to occur regardless of worsening independence in ADL because our data showed that worsening of difficulties in ADL were also triggered by hospitalization in the older HF patients who experienced no decrease of independence in ADL. This is a major finding of the present study. A previous study reported that difficulties in ADL in HF patients are strongly affected by exercise capacity,²⁰ which is strongly affected by leg muscle strength.³⁷ Because we previously reported that worsening of leg muscle strength is triggered by hospitalization in older HF patients despite receiving CR during hospitalization,⁷ we consider that exercise capacity would also be worsened by hospitalization in these patients and, accordingly, that hospitalization triggered worsening of difficulties in ADL in the older HF patients in the present study. Conversely, in the non-older patients, because we previously reported that leg muscle strength is not worsened by hospitalization,⁷ we assumed that hospitalization did not trigger worsening of difficulties in ADL in these patients. Incidentally, because evidence for CR during hospitalization is insufficient compared with that for CR after hospital discharge in HF patients, we may not have been able to provide effective CR during hospitalization, and this issue needs to be addressed in the future.

The risk of hospital readmission for cardiovascular events (including HF) is affected by several factors in HF patients. Previous studies reported that nutrition status,³⁸ HF with reduced ejection fraction,³⁹ dementia,³⁹ and outpatient rehabilitation⁴⁰ affect the risk of hospitalization in HF patients. Especially, independence in ADL is a strongly relevant factor for risk of rehospitalization in older HF patients.^{10,11} It is also assumed that age, sex, BMI, length of hospitalization, duration of HF, severity of HF, medication, renal function, and anemia also affect risk of rehospitalization in HF patients.^{41,42} We clarified in this study that difficulties in ADL are a relevant factor for risk of rehospitalization even when adjusted for by these several factors and independence in ADL. Several previous studies^{21,22} also reported that difficulties in ADL are a relevant factor for risk of rehospitalization, but as these studies^{21,22} did not adjust for independence in ADL, the effect of independence in ADL on hospital readmission could not be completely excluded. Thus, the result that difficulties in ADL are a relevant factor for risk of hospitalization adjusted by independence in ADL is another major finding of the present study.

Additionally, we considered the correlation between the PMADL-8 and Katz index in the stable phase before admission and at hospital discharge to be low because a correlation coefficient in the range of 0.2 to 0.4 generally indicates low correlation.

Thus, we think that assessment of independence in ADL and difficulties in ADL as separate entities is needed during hospitalization.

Limitations

The present study has some limitations. First, neither the adherence rate to prescribed exercise intensity nor the exercise dose in CR during hospitalization was recorded in the present study. Second, selection bias is present in this study because we included patients with acute decompensated HF who could walk independently at home before hospital admission and received CR during hospitalization. Also, we did not conduct a sex-based analysis. Third, because the length of hospitalization is longer in Japan than in Europe and the United States, a future prospective study in countries with shorter hospitalization times is needed to verify the present results. Fourth, scores of the Katz index and PMADL-8 during the stable phase before hospital admission were retrospectively determined based on patient reporting at the time of enrollment.

Conclusions

The present data indicate that worsening not only of independence in ADL but also of difficulties in ADL was triggered by hospitalization in older HF patients even if they were receiving CR, and difficulties in ADL are a relevant factor for the risk of

hospitalization regardless of a patient's independence in ADL. These findings suggest that we may need to focus not only on independence in ADL but also difficulties in ADL during and after hospitalization of older patients with HF.

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Conflicts of interest

The authors certify that there are no conflicts of interest with any financial organizations regarding the material discussed in this manuscript.

Data availability

The data underlying this article cannot be shared publicly due to the privacy of individuals that participated in the study. The data will be shared on reasonable request to the corresponding author.

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Figure legends

Figure 1 Patient flow in this study.

Figure 2 Changes in the Katz index between the stable phase before admission and hospital discharge in all patients and each group. Total score of the Katz index ranges from A to G, where a score of A represents an independent patient and G a very dependent one. *Stable phase before admission vs. Hospital discharge.

Figure 3 Changes in the Performance Measure for Activities of Daily Living-8 (PMADL-8) score between the stable phase before admission and hospital discharge in all patients and each group. Scores of the PMADL-8 range from 8 to 32, with higher scores reflecting more severe difficulties in ADL.

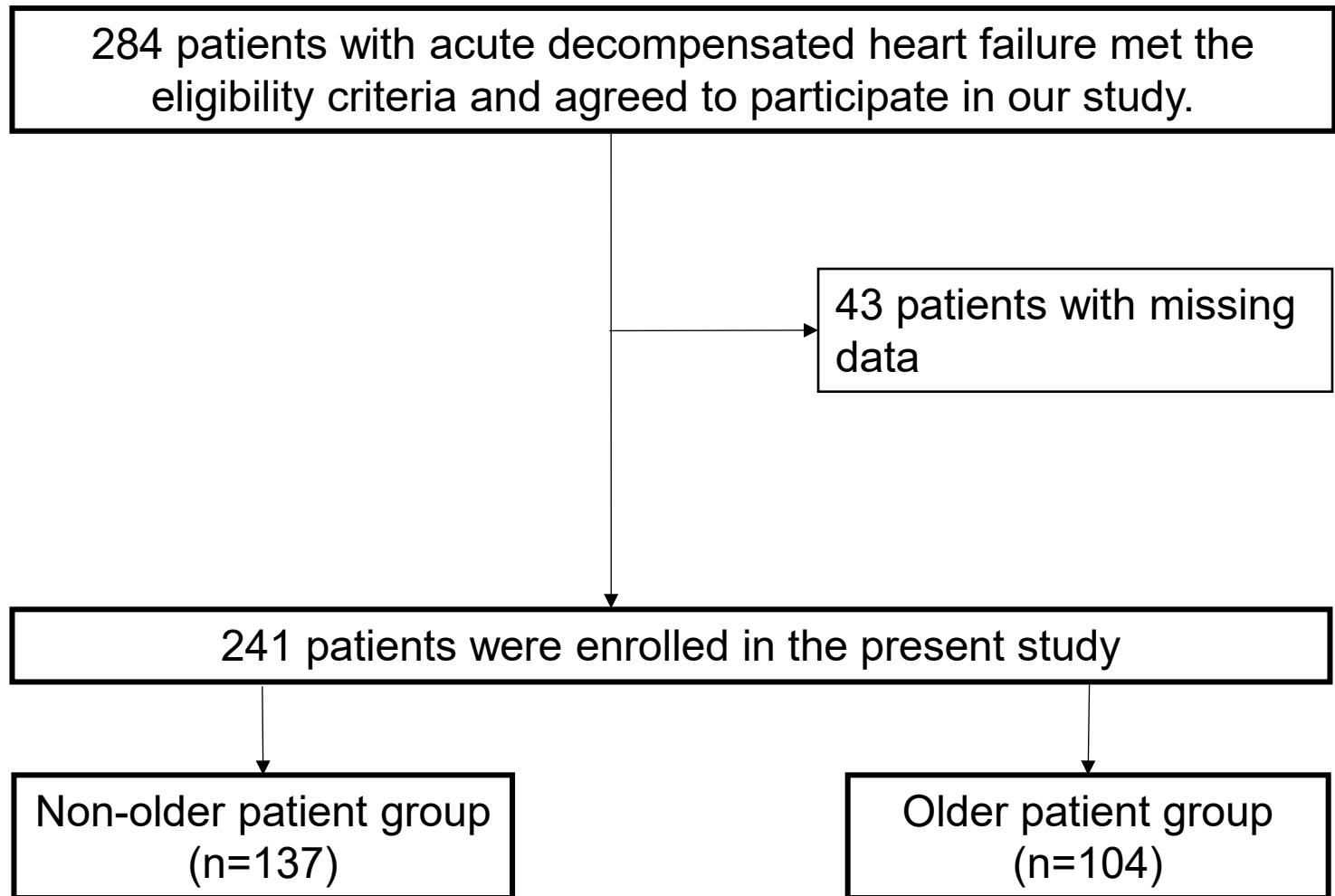
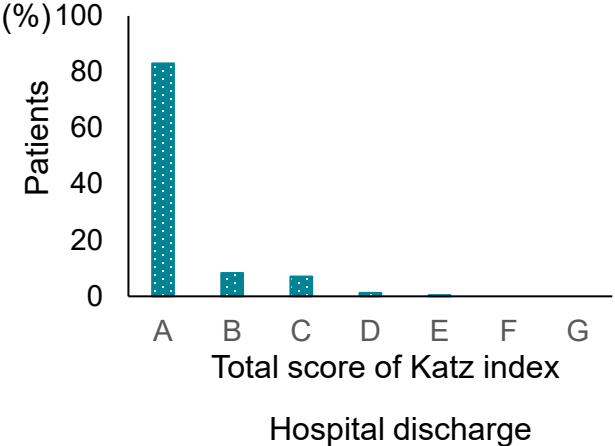
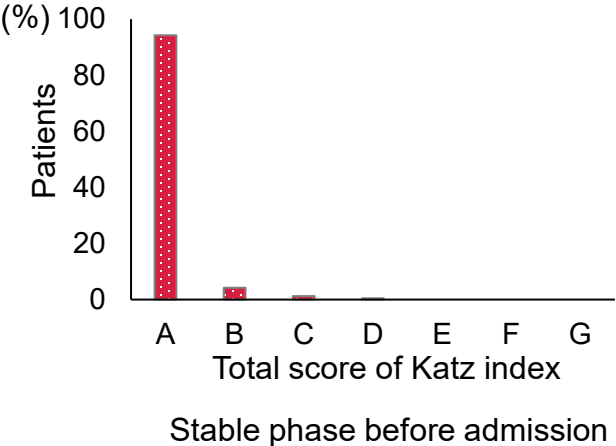


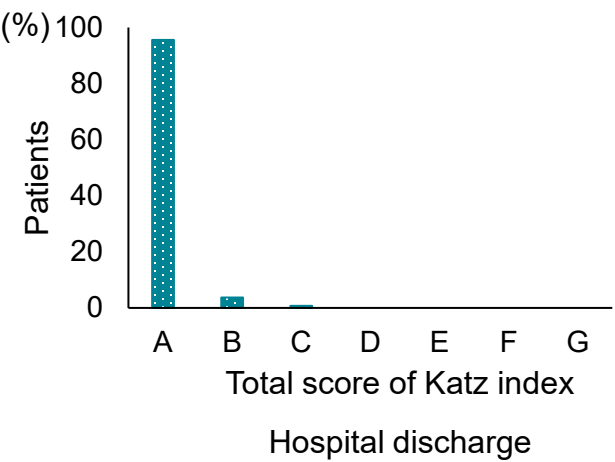
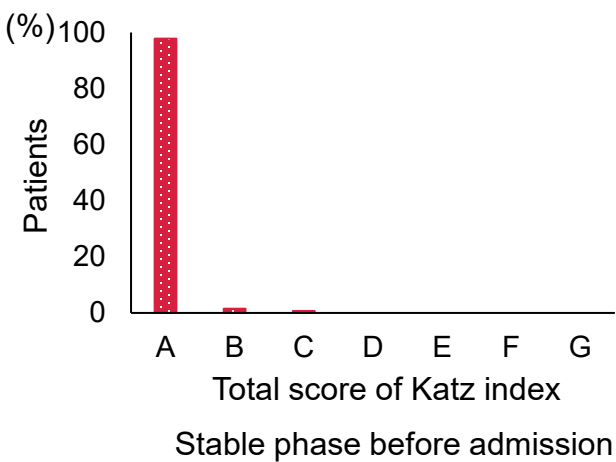
Fig. 1

a. All patients



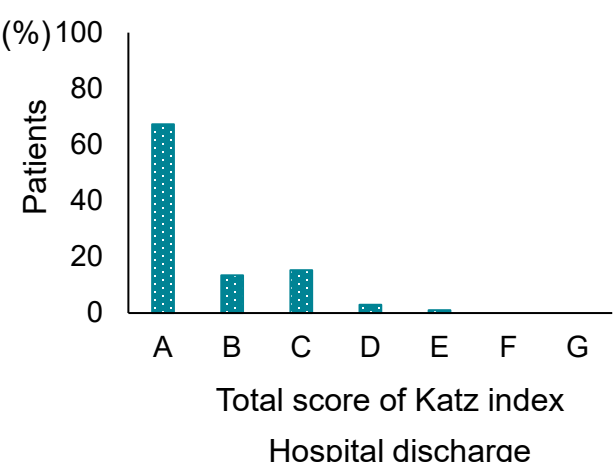
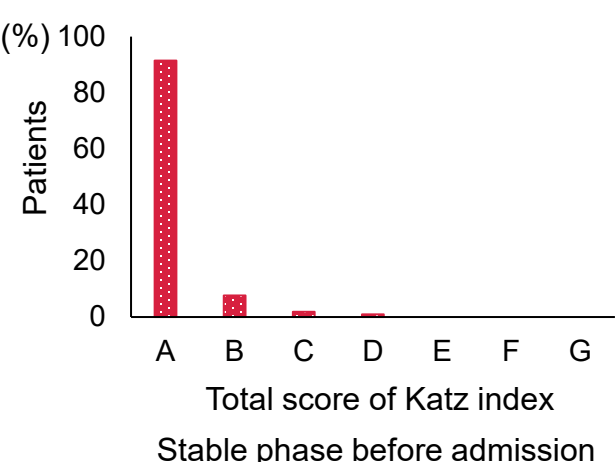
P<0.001*

b. Non-older patient group
(age < 75 years)



P=0.083*

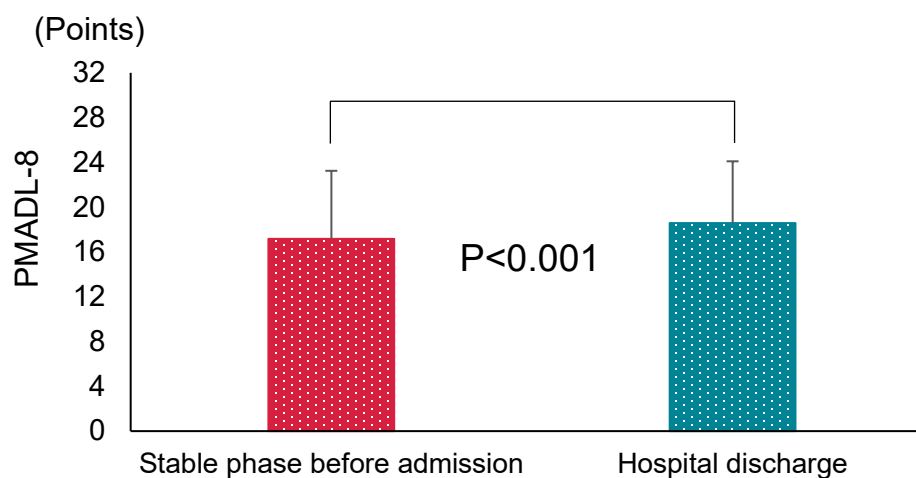
c. Older patient group
(age ≥ 75 years)



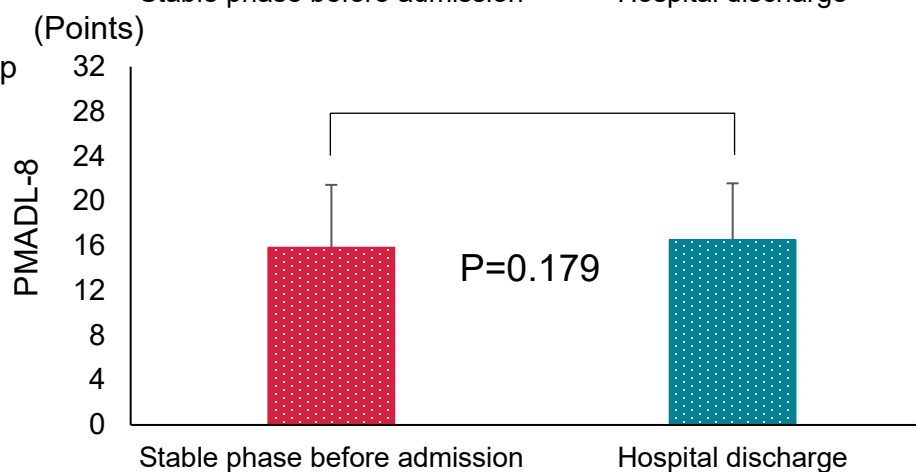
P<0.001*

Fig. 2

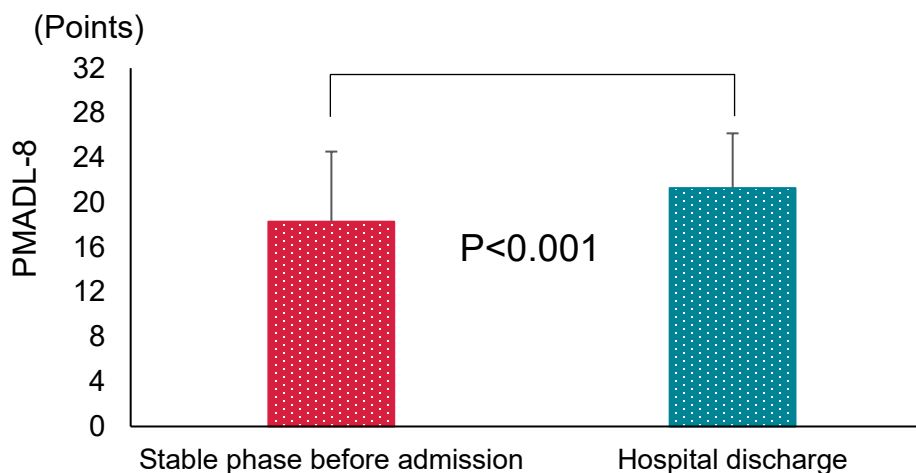
a. All patients



b. Non-older patient group
(age < 75 years)



c. Older patient group
(age ≥ 75 years)



■ Total score of PMADL-8 at stable phase before admission

■ Total score of PMADL-8 at hospital discharge

Fig. 3

Table 1 Clinical characteristics of all study patients and patients by group

Variables	All patients	Non-older patient group (age < 75 years)	Older patient group (age ≥ 75 years)	P-value*
	(n=241)	(n=137)	(n=104)	
Age (years)	69.5±14.2	59.9±10.8	82.3±5.0	<0.001
Male sex	169 (70.1)	107 (78.1)	62 (59.6)	0.002
BMI at discharge (kg/m ²)	22.8±4.9	24.2±5.5	21.0±3.0	<0.001
LVEF <40%	131 (54.4)	91 (66.4)	40 (38.5)	<0.001
LVEF ≥40% to <50%	50 (20.7)	25 (18.3)	25 (24.0)	
LVEF ≥50%	60 (24.9)	21 (15.3)	39 (37.5)	
NYHA functional classification before admission				
I/II/III/IV	6/168/63/4	3/95/36/3	3/73/27/1	0.883
AHA/ACC HF Classification before admission				
Stage A/B/C/D	36/45/129/31	26/23/70/18	10/22/59/13	0.218
Times of admission for HF, 0/1/2	144/45/52	95/14/28	49/31/24	<0.001
HF etiology				
Ischemic heart disease	76 (31.5)	33 (24.1)	43 (41.3)	<0.001
Cardiomyopathy	79 (32.8)	66 (48.2)	13 (12.5)	
Valvular heart disease	31 (12.9)	13 (9.5)	18 (17.3)	
Others	55 (22.8)	25 (18.2)	30 (28.8)	
Comorbidities				
Diabetes mellitus	87 (36.1)	51 (37.2)	36 (34.6)	0.676
Chronic kidney disease	94 (39.0)	47 (34.1)	47 (45.2)	0.086
Orthopedic disease	27 (11.2)	13 (9.5)	14 (13.5)	0.333
Cerebrovascular disease	35 (14.5)	20 (14.6)	15 (14.4)	0.970
Acute-phase treatment				
Respirator	7 (2.9)	5 (3.7)	2 (1.9)	0.429
Mechanical circulatory assistance	5 (2.1)	2 (1.5)	3 (2.9)	0.442
Noradrenalin	4 (1.7)	2 (1.5)	2 (1.9)	0.773
Catecholamine	34 (14.1)	21 (15.3)	13 (12.5)	0.532
Maximum BNP (n=170)	791.8 [487.2, 1411.4]	872.2 [515.1, 1559.7]	729.7 [466.9, 1186.4]	-
Maximum NT-proBNP (n=71)	6189.0 [2691.0, 14459.0]	5493.0 [1963.5, 11889.0]	7668.5 [2972.3, 16101.8]	-
Log BNP	3.8±0.4	3.8±0.4	3.8±0.4	0.881
eGFR at discharge (mL/min/1.73 m ²)	49.2±20.1	55.2±20.6	41.2±16.4	<0.001
Hemoglobin at discharge (g/dL)	12.5±2.4	13.4±2.3	11.1±1.7	<0.001
RAS inhibitor	176 (73.0)	115 (83.9)	61 (58.7)	<0.001
Beta-blocker	211 (87.6)	130 (94.9)	81 (77.8)	<0.001
Time between admission and start of walking (days)	2.0 [1.0, 5.0]	3.0 [1.0, 5.0]	2.0 [1.0, 5.0]	0.402
Length of hospitalization (days)	20.0 [15.0, 26.0]	21.0 [15.5, 26.0]	18.5 [13.0, 25.8]	0.049
MNA-SF in the stable phase, 0-7/8-11/12-14	34/121/86	11/66/60	23/55/26	<0.001
MMSE at discharge	26.7±3.2	27.4±2.7	25.6±3.5	<0.001
Outpatient CR after discharge	105 (43.6)	63 (46.0)	42 (40.4)	0.385

Values are expressed as mean ±SD, median [interquartile range], number (%), or number. * Non-older patient group vs. older patient group.

BMI, body mass index; LVEF, left ventricular ejection fraction; NYHA, New York Heart Association; AHA, American Heart Association; ACC, American College of Cardiology; HF, heart failure; BNP, brain natriuretic peptide; NT-proBNP; N-terminal pro-brain natriuretic peptide; eGFR, estimated glomerular filtration rate; RAS, renin-angiotensin system; MNA-SF, Mini Nutritional Assessment-Short Form; MMSE; Mini Mental State Examination; CR, cardiac rehabilitation.

Table 2 Univariate and multivariate Cox regression models for cardiac events in all patients

	PMADL-8 at discharge per 5-point increase	
	HR (95% CI)	<i>P</i> value
Univariate Cox Model	1.44 (1.13 to 1.82)	0.003
Model 1		
Adjusted by age, sex, and BMI	1.41 (1.07 to 1.86)	0.014
Model 2		
Adjusted by Model 1 variables + Katz index	1.58 (1.17 to 2.15)	0.003
Model 3		
Adjusted by Model 2 variables + LVEF <40% + Length of hospitalization + Times of admission for HF + RAS inhibitor + Beta-blocker + eGFR at discharge +Log BNP + Hemoglobin at discharge + MNA-SF in the stable phase + MMSE at discharge + Outpatient rehabilitation	1.42 (1.01 to 2.01)	0.042

PMADL-8, Performance Measure for Activities of Daily Living-8; HR, hazard ratio; CI, confidence interval; BMI, body mass index; LVEF, left ventricular ejection fraction; HF, heart failure; RAS, renin-angiotensin system; eGFR, estimated glomerular filtration rate; BNP, brain natriuretic peptide; MNA-SF, Mini Nutritional Assessment-Short Form; MMSE, Mini Mental State Examination.

Table 3 Univariate and multivariate Cox regression models for rehospitalization for heart failure in all patients

	PMADL-8 at discharge per 5-point increase	
	HR (95% CI)	<i>P</i> value
Univariate Cox model	1.46 (1.15 to 1.87)	0.002
Model 1		
Adjusted by age, sex, and BMI	1.44 (1.09 to 1.92)	0.011
Model 2		
Adjusted by Model 1 variables + Katz index	1.61 (1.18 to 2.21)	0.003
Model 3		
Adjusted by Model 2 variables + LVEF <40% + Length of hospitalization + Times of admission for HF + RAS inhibitor + Beta-blocker + eGFR at discharge + Log BNP + Hemoglobin at discharge + MNA-SF in the stable phase + MMSE at discharge + Outpatient rehabilitation	1.50 (1.07 to 2.13)	0.021

PMADL-8, Performance Measure for Activities of Daily Living-8; HR, hazard ratio; CI, confidence interval; BMI, body mass index; LVEF, left ventricular ejection fraction; HF, heart failure; RAS, renin-angiotensin system; eGFR, estimated glomerular filtration rate; BNP, brain natriuretic peptide; MNA-SF, Mini Nutritional Assessment-Short Form; MMSE; Mini Mental State Examination.