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Original Article

Prealbumin level is a predictor of activities of daily living at discharge in older patients with heart failure who became ADL-independent after hospitalization – Acute and early recovery cardiac rehabilitation trials

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ABSTRACT

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Objective: To determine the relationship between prealbumin level and activities of daily living (ADL) at discharge in patients with heart failure (HF) and assess the usefulness of prealbumin measurement in predicting discharge Barthel Index (BI) in older patients with HF who become non-independent in ADL after hospital admission.

Methods: Patients with HF, aged ≥75 years, who were admitted to an acute hospital and underwent acute and early recovery cardiac rehabilitation (CR) were studied retrospectively. The exclusion criteria were non-independent ADL before admission (BI < 85 points) and independent ADL at the start of CR (BI ≥ 85 points). The usefulness of prealbumin level in predicting discharge BI was compared between four models. Albumin and Controlling Nutritional Status (CONUT) were used as comparison variables. The models and independent variables were model 1 (covariates only), model 2 (prealbumin + covariates), model 3 (albumin + covariates), and model 4 (CONUT score + covariates). Adjusted R^2, a measure of model fit, was used to compare predictive ability.

Results: A total of 152 patients were included in the analysis. Prealbumin level was a significant variable for BI at discharge but not albumin or CONUT. The adjusted R^2 was higher in model 2 with the addition of prealbumin than that in model 1 (0.362 vs. 0.347).

Conclusion: Prealbumin levels are useful in predicting discharge BI in older patients with HF who become non-independent in ADL after hospitalization.

Key words: Heart failure, Prealbumin, Activities of daily living, Cardiac rehabilitation

Introduction

The average age of patients with heart failure (HF) in Japan is 77.8 years [1], and the proportion of older patients is likely to continue to increase [2]. Older patients with HF have many comorbidities, including malnutrition [3]. Acute nutritional assessment and management are important because malnutrition can lead to increased skeletal muscle catabolism and subsequent decline in physical function related to activities of daily living (ADL) after cardiac rehabilitation [4]. Therefore, guidelines [5] recommend a combination of exercise and nutritional therapy, but no consensus exists on nutritional indicators in the acute phase of HF.

Reports on ADL and nutritional indicators in acute HF have shown that among several nutritional indicators, only the Controlling Nutritional Status (CONUT) [6] is useful in predicting ADL decline [7]. However, there is no consensus on the ability of the CONUT score to predict ADL at discharge, considering some reports show no significant

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association between the acute CONUT score and ADL at discharge [8]. This may be because the components of CONUT—albumin, total lymphocyte count, and total cholesterol—can all fluctuate during the acute phase of HF because of increased inflammation, dilution by increased fluid volume, and metabolic stress, and each component is a relatively long-term indicator of CONUT. Indeed, in recent years, albumin and prealbumin have been considered nutritional risk indicators rather than nutritional indicators [5, 9], as they are poorly correlated with dietary intake and decrease with inflammation [9]. Inflammation-induced hypercatabolism, anabolic inhibition, and anorexia lead to reduced skeletal muscle mass and malnutrition [10]. Albumin and prealbumin levels might serve as indicators of inflammation and thus as predictors of reduced ADL in patients with HF. In particular, prealbumin has a short blood half-life of approximately two days [11] and may be useful in predicting ADL at discharge in patients with acute HF.

In a cohort of older patients with HF in Japan, more than 80% were ≥75 years of age, and the extent of ADL improvement during hospitalization owing to cardiac rehabilitation has been shown to be a prognostic factor [12]. Therefore, it is important to improve ADL that are reduced on admission in patients with HF who are ≥75 years of age. However, the relationship between prealbumin level and ADL is not fully understood. The present study investigated the association between prealbumin level and ADL at discharge in patients with HF aged ≥75 years who became non-independent in ADL after hospital admission.

Methods

1. Subjects

This was a single-center, retrospective, observational study. The inclusion criteria were (1) patients aged ≥75 years admitted to the cardiology department of an acute hospital with a diagnosis of HF between April 2016 and September 2020 and (2) patients for whom cardiac rehabilitation was prescribed by a physician during the admission period. The exclusion criteria were ADL independence before admission (Barthel Index [BI] [13] < 85 points [14]), independence in ADL at the start of cardiac rehabilitation (BI ≥ 85 points [14]), missing data, discharge owing to death, no acute cardiac rehabilitation, and refusal of cardiac rehabilitation. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki (amended October 2013) and the Ethical Guidelines for Medical Research Involving Human Subjects (partially amended 28 February 2017) and was approved by the Ethics Committee of the National Hospital Organization Sendai Medical Center (No. 21-1). As this was a retrospective study, an information disclosure document was made available to eligible patients on the website of the Sendai Medical Center.

2. Data collection

Baseline characteristics data such as age, sex, height, weight, body mass index (BMI), underlying HF, comorbidities, medical history, medications, New York Heart Association (NYHA) classification on admission [15], left ventricular ejection fraction, blood and biochemical test results, and length of hospital stay were collected from electronic medical records. In addition, nutritional status at admission and discharge, ADL and physical function at the start of cardiac rehabilitation and discharge, as well as the date of cardiac rehabilitation initiation and the number of days and hours of cardiac rehabilitation during hospitalization, were collected from the electronic medical records.

The long-term nutritional risk indicator albumin [9] and the CONUT score [6] were selected as comparators to assess the usefulness of prealbumin measurement as a nutritional risk indicator in predicting ADL at discharge. Albumin has a blood half-life of approximately 20 days [11] and is considered useful in assessing nutritional risk in non-acute settings [9]. It is a nutritional index consisting of three items: albumin, total cholesterol, and total lymphocyte count, calculated on a scale of 0 to 12. A score of 0−1 is normal, while 2−4 is defined as mildly malnourished, 5−8 as moderately malnourished, and ≥9 as severely malnourished [6]. The BI [13] was used as a measure of ADL. Pre-admission BI was determined at the start of cardiac rehabilitation based on medical records and information from patients and families. The Short Physical Performance Battery (SPPB) [16] and grip strength [17] were used as indicators of physical function.

3. Cardiac rehabilitation

The implementation and progression criteria for cardiac rehabilitation were in accordance with the Japanese Cardiovascular Society Guidelines for Rehabilitation in Cardiovascular Disease [5]. Acute cardiac rehabilitation is defined as "a weaning program initiated in the intensive care unit, coronary care unit, or ward," whereas early recovery cardiac rehabilitation is defined as "a comprehensive disease management program, including exercise therapy, conducted during hospitalization after stabilization of the condition" [5]. Therefore, during acute cardiac rehabilitation, the bed-release program was carried out while ensuring that the hemodynamic status did not deteriorate, and the level of movement was progressively increased from sitting on the edge to standing, walking to the toilet, and walking in the wing. During the subsequent cardiac rehabilitation in the early recovery phase, after completion of the weaning program, exercise therapy was initiated, confirming that there was no worsening of HF symptoms and no contraindications to exercise therapy, and was continued until the patient was discharged. The exercise program consisted of

stretching, resistance training, aerobic exercise, and ADL exercises performed five times a week. Heart rate reserve using the Karvonen method and subjective exercise intensity using the Borg index were used to determine exercise intensity.

4. Statistical analysis

G*power version 3.1.9.7 (Heinrich-Heine-University, Düsseldorf, Germany; http://www.gpower.hhu.de/) was used to calculate the sample size. According to the pre-analysis of this study, the required sample size was 123 cases, calculated at significance level = 0.05, power = 0.8, effect size $f^2 = 0.15$, and explanatory variables = 11. Cohen's criteria [18] were used to determine effect size.

Continuous variables are presented as mean and standard deviation for parametric data, the median and interquartile range for non-parametric data, and nominal variables as the number of persons (%). The Shapiro-Wilk test was used to test for the presence of a normal distribution. Comparisons between parameters at admission or the start of cardiac rehabilitation and at discharge were made using the *t*-test or the Wilcoxon signed-rank test, with or without normal distribution. Multiple regression analysis was used to examine factors associated with BI and R^2 at discharge. The study used four models for multiple regression analysis. Variables that were found to influence ADL in patients with HF in previous studies (age [19], sex [20], BMI [21], presence of dementia [21], NYHA classification [22], N-Terminal pro Brain Natriuretic Peptide (NT-proBNP) [22], hemoglobin [22], BI [23], SPPB [24] and grip strength [25]) were selected for model 1. The other models were model 2 (model 1 + prealbumin), model 3 (model 1 + albumin), and model 4 (model 1 + CONUT). R^2 and adjusted R^2 were compared for each model. Spearman's rank correlation coefficient was used to assess multicollinearity, and factors showing a slightly stronger correlation ($r > 0.50$) were excluded as one of the independent factors [26]. Statistical analysis was performed using JMP version 13.1.0 (SAS Institute, Cary, NC, USA) at a 5% significance level.

Results

Of the 406 cases that met the inclusion criteria, 152 were included in the analysis, leaving 254 cases that met the exclusion criteria (Figure 1).

1. Baseline characteristics

The median age of the subjects was 85.0 years, and 42.5% were very old [27], aged ≥85 years. The median length of hospital stay was 29.0 days, and the median number of days of cardiac rehabilitation was 23.0. The median BI at the start of cardiac rehabilitation was 55.0 points, the median BI at discharge was 95.0 points, and 73.0% of patients were considered independent in ADL at discharge (Table 1).

The median prealbumin on admission was 17.0 mg/dL, and the mean albumin was 3.5 ± 0.4 g/dL; among the CONUTs, 56.6% of the patients had mild malnutrition, 27.6% had moderate malnutrition, and 1.3% had severe malnutrition; the median SPPB was 4.0 points (Table 2).

The median prealbumin level at discharge was 19.0

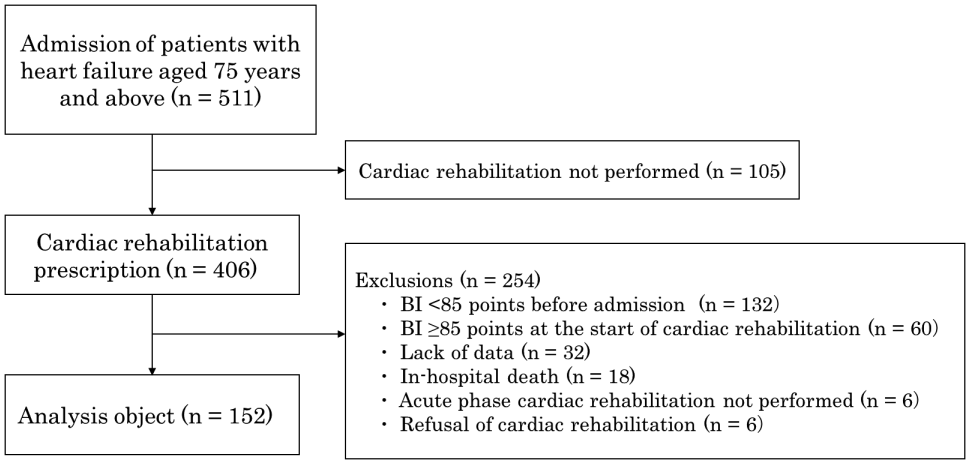

Figure 1. Flow diagram of study patient selection.
This single-center, backward-looking, observational study included 406 of 511 patients with HF aged ≥75 years or older admitted to an acute-care hospital cardiology department between April 2016 and September 2020. Of these, 406 patients were prescribed cardiac rehabilitation. The exclusion criteria were as follows: non-independent ADL (Barthel Index (BI) < 85 points [17]) before admission ($n = 132$), independent ADL (BI ≥ 85 points [17]) at the start of cardiac rehabilitation ($n = 60$), missing data ($n = 32$), discharge owing to death ($n = 18$), taking about one month before cardiac rehabilitation prescription ($n = 6$), and refusal of cardiac rehabilitation ($n = 6$); a total of 254 patients were excluded, leaving 152 patients for the analysis.

Table 1. Basic characteristics and cardiac rehabilitation practices.

	n=152
Physical characteristics	
Age (years)	85.0 (80.0–88.0)
Sex (female)	98 (65.3)
Height (cm)	151.9±10.4
Weight (kg)	52.0 (45.0–60.6)
BMI (kg/m^2)	23.4±4.0
Primary disease	
Ischaemic heart disease	42 (28.0)
Valvular disease	31 (20.6)
Cardiomyopathy	9 (6.0)
Congenital heart disease	1 (0.6)
Hypertensive heart failure	27 (18.0)
Arrhythmogenic heart failure	49 (32.6)
Comorbidities	
Diabetes mellitus	60 (39.5)
Hypertension	114 (75.0)
Hyperlipidaemia	37 (24.3)
Hyperuricemia	17 (11.2)
Medical history	
Cerebrovascular disease	23 (15.1)
Neuromuscular disease	2 (1.3)
Respiratory disease	16 (10.5)
Cancer	30 (19.7)
Dementia	9 (6.0)
Mental disorder	7 (4.6)
Medication (on admission)	
ACE inhibitor	25 (16.3)
ARBs	60 (39.5)
Beta-blockers	53 (34.9)
Calcium channel blockers	60 (39.5)
Diuretics	140 (92.1)
Digoxin	11 (7.2)
Statins	30 (20.0)
Clinical findings (on admission)	
NYHA (I / II / III / IV)	4/13/83/52
Ejection Fraction (%)	57.0 (35.0–65.8)
NT-proBNP (pg/mL)	4905.0 (2701.5–10919.5)
Haemoglobin (g/dL)	11.1±2.3
CRP (mg/dL)	0.4 (0.2–1.8)
eGFR (mL/min/1.73m^2)	38.9 (26.9–51.8)
Peripheral blood lymphocyte count (μL)	1070.0 (710.0–1530.0)
Total cholesterol (mg/dL)	167.9±37.4
Total protein (g/dL)	6.6 (6.3–7.1)
Length of hospital stay (days)	29.0 (19.8–39.0)
CR	
Start of CR (days)	5.0 (3.0–9.0)
CR days (days)	23.0 (15.0–34.0)
CR duration (min/day)	46.1±12.7
BI before admission (score)	100.0 (90.0–100.0)
BI at start of CR (score)	55.0 (30.0–65.0)
BI at discharge (score)	95.0 (80.0–100.0)
BI at discharge (≥85 score)	111 (73.0)

Data are presented as mean ± SD or median (quartile range), numbers of subjects per group (%)
BMI, Body Mass Index; ACE, Angiotensin Converting Enzyme; ARB, Angiotensin Receptor Blocker; NYHA, New York Heart Association; NT-proBNP, N-Terminal pro Brain Natriuretic Peptide; CRP, C-Reactive protein; eGFR, estimated Glomerular Filtration Rate; CR, Cardiac Rehabilitation; BI, Barthel Index.

Table 2. Nutritional status and physical function.

	n=152		
	On admission / at start of CR	At discharge	*P*-value
Prealbumin (mg/dL)	17.0 (13.0–21.0)	19.0 (14.0–23.0)	0.003
Albumin (g/dL)	3.5±0.4	3.3±0.4	<0.001
CONUT (points)	3.5 (2.0–5.0)	4.0 (2.0–5.0)	0.213
Normal	22 (14.5)	24 (15.7)	
Mildly malnourished	86 (56.6)	72 (47.1)	
Moderately malnourished	42 (27.6)	51 (33.3)	
Severely malnourished	2 (1.3)	5 (3.3)	
SPPB (points)	4.0 (1.0–6.0)	7.0 (4.0–9.0)	<0.001
Handgrip strength (kg)	16.2 (13.0–20.4)	16.3 (13.1–20.9)	0.243

Data are presented as mean ± SD or median (quartile range), numbers of subjects per group (%)
CR, Cardiac Rehabilitation; CONUT, Controlling Nutritional Status; SPPB, Short Physical Performance Battery.

mg/dL, and the mean albumin level was 3.3 ± 0.4 g/dL. Among the CONUTs, 47.1% had mild malnutrition, 33.3% had moderate malnutrition, and 3.3% had severe malnutrition. The median SPPB score at discharge was 7.0 points. A comparison of parameters between admission and discharge showed a significant increase in prealbumin levels, a significant decrease in albumin levels, and a significant improvement in SPPB at discharge (Table 2).

2. Factors associated with discharge BI

Prior to multiple regression analysis, multicollinearity was assessed using Spearman's rank correlation coefficient. SPPB at the start of cardiac rehabilitation was excluded from the independent variables because of a slightly stronger correlation (r = 0.586) between BI and SPPB at the start of cardiac rehabilitation (Table 3). The independent variables were age, sex, BMI, presence of dementia, NYHA classification, NT-proBNP, hemoglobin, BI at baseline, grip strength, and prealbumin, albumin, and CONUT scores at baseline. After adjusting for covariates and comparing models, only prealbumin was a significant predictor of BI at discharge. Model 2 had a better fit than model 1 (Table 4).

Discussion

The novelty of this study is that prealbumin levels were found to be useful in predicting discharge BI in older patients with HF and non-independent ADL after hospitalization. The results of this study may contribute to the selection of criteria for patients requiring nutritional management and the choice of indicators to be used in this context.

Multiple regression analysis of each model showed that prealbumin level was the only independent predictor of discharge BI. This suggests that physical impairment and malnutrition secondary to inflammation limit ADL improvement. Although the causal relationship between inflammation and poor physical function is not entirely clear, several reports support an association between inflammation and poor physical function [28, 29]. It has been suggested that patients with HF have elevated blood levels of inflammatory cytokines, such as tumor necrosis factor-alpha (TNF-α), interleukin (IL)-6, and IL-β, indicating an inherent skeletal muscle myopathy [30]. TNF-α and IL-6 are associated with the inhibition of skeletal muscle anabolism and increased catabolism, whereas IL-β is associated with impaired mitochondrial function and oxygen metabolism [31]. Signaling of these inflammatory cytokines induces skeletal muscle cell damage and muscle atrophy [30–32]. Koshikawa et al. found that older HF patients have increased skeletal muscle proteolysis compared to healthy older subjects. Further, they showed that a positive correlation exists between C-reactive protein (CRP) levels and skeletal muscle proteolysis and a negative correlation between CRP levels and knee extensor muscle strength [33]. Grip strength also did not change significantly before and after cardiac rehabilitation in the present study, suggesting that inflammation in patients with HF may have limited the improvement in skeletal muscle strength and prevented recovery of ADL. Systemic inflammation may also lead to malnutrition, which has been shown to limit ADL [34]. Hyponutritional status in patients with heart disease is associated with ADL at discharge [4], skeletal muscle strength [35], and walking speed [35]. In the present study, no significant changes in CONUT score were found before and after cardiac rehabilitation, and patients classified as moderately or severely malnourished showed an increase in CONUT score at discharge. Thus, poor nutritional status secondary to systemic inflammation may have limited the improvement in skeletal muscle strength and resulted in limitation of ADL at discharge.

In contrast, CONUT score and albumin level were not found to be significant predictors of BI at discharge. A possible reason for this is that albumin and total

Table 3. Correlation of patient data.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 on admission to hospital Prealbumin	–	0.417**	−0.411**	−0.125	0.132	0.057	−0.113	−0.049	−0.044	−0.036	0.130	0.184*	−0.098
2 On admission Albumin		–	−0.670**	−0.117	0.123	0.119	−0.076	0.087	−0.255*	0.274**	0.128	0.173*	0.058
3 CONUT on admission			–	0.057	−0.118	−0.076	0.153	−0.054	0.177*	−0.332**	−0.143	−0.181*	−0.016
4 Age				–	0.030	−0.179*	0.216*	0.143	0.025	−0.123	−0.105	−0.231*	−0.364**
5 Sex					–	0.205*	0.067	0.088	−0.055	−0.095	−0.054	−0.240*	−0.582**
6 BMI						–	−0.099	−0.230*	−0.323**	0.031	0.039	0.048	0.046
7 Dementia							–	0.128	0.176*	−0.098	−0.175	−0.169*	−0.046*
8 NYHA								–	0.055	0.054	−0.29**	−0.227*	−0.180*
9 NT-proBNP									–	−0.152	−0.154	−0.083	−0.104
10 Haemoglobin										–	−0.009	0.073	0.131
11 BI at start of CR											–	0.586**	0.297**
12 SPPB at start of CR												–	0.441**
13 Handgrip strength at start of CR													–

* $p<0.05$, ** $p<0.001$

CONUT, Controlling Nutritional Status; BMI, Body Mass Index; NYHA, New York Heart Association; NT-proBNP, N-Terminal pro Brain Natriuretic Peptide; BI, Barthel Index; CR, Cardiac Rehabilitation; SPPB, Short Physical Performance Battery.

Table 4. Factors associated with BI at hospital discharge.

Model 1	B	β	*P*-value	95%CI	
Age	−0.792	−0.240	0.002	−1.289,	−0.296
Sex	−1.075	−0.056	0.542	−4.555,	2.405
BMI	0.511	0.113	0.124	−0.142,	1.165
dementia	6.660	0.173	0.013	1.400,	11.920
NYHA on admission	−1.726	−0.067	0.358	−5.430,	1.977
NT-proBNP on admission	0.000	0.104	0.142	−4.741,	0.000
Haemoglobin on admission	0.752	0.095	0.167	−0.317,	1.822
BI at start of CR	0.296	0.393	<0.001	0.182,	0.411
Handgrip strength at start of CR	0.012	0.004	0.967	−0.557,	0.581
Model 2 (Model 1 + Prealbumin)	**B**	**β**	***P*-value**	**95%CI**	
Prealbumin on admission	0.434	0.136	0.042	0.016,	0.853
Age	−0.743	−0.259	0.003	−1.236,	−0.249
Sex	−0.977	−0.166	0.576	−4.420,	2.465
BMI	0.516	0.389	0.117	−0.131,	1.162
dementia	6.184	0.140	0.021	0.963,	11.405
NYHA on admission	−1.700	−0.066	0.360	−5.362,	1.962
NT-proBNP on admission	0.000	0.100	0.156	−5.169,	0.000
Haemoglobin on admission	0.764	0.094	0.165	−0.311,	1.803
BI at start of CR	0.289	0.383	<0.001	0.176,	0.402
Handgrip strength at start of CR	0.060	0.021	0.835	−0.505,	0.624
Model 3 (Model 1 + Albumin)	**B**	**β**	***P*-value**	**95%CI**	
Albumin on admission	2.971	0.071	0.319	−2.902,	8.843
Age	−0.778	−0.235	0.002	−1.275,	−0.280
Sex	−0.864	−0.045	0.627	−4.369,	2.641
BMI	0.507	0.112	0.127	−0.147,	1.161
dementia	6.583	0.171	0.015	1.321,	11.846
NYHA on admission	1.878	−0.072	0.324	−5.574,	1.852
NT-proBNP on admission	0.000	0.111	0.119	−0.000,	0.000
Haemoglobin on admission	0.560	0.076	0.288	−0.511,	1.711
BI at start of CR	0.294	0.390	<0.001	0.180,	0.408
Handgrip strength at start of CR	−0.010	−0.004	0.972	−0.581,	0.561
Model 4 (Model 1 + CONUT)	**B**	**β**	***P*-value**	**95%CI**	
CONUT on admission	−0.414	−0.045	0.523	−1.172,	0.894
Age	−0.797	−0.241	0.002	−1.295,	−0.299
Sex	−0.951	−0.050	0.593	−4.461,	2.558
BMI	0.515	0.114	0.122	−0.140,	1.170
dementia	6.454	0.168	0.018	1.142,	11.765
NYHA on admission	−1.781	−0.069	0.345	−5.497,	1.934
NT-proBNP on admission	0.000	0.108	0.132	−0.000,	0.000
Haemoglobin on admission	0.638	0.080	0.267	−0.493,	1.769
BI at start of CR	0.293	0.389	<0.001	0.178,	0.408
Handgrip strength at start of CR	0.007	0.002	0.981	−0.564,	0.577

R^2 and adjusted R^2

Model 1: 0.386, 0.347. Model 2: 0.404, 0.362. Model 3: 0.391, 0.347. Model 4: 0.388, 0.344.

CI, Confidence Interval; BMI, Body Mass Index; NYHA, New York Heart Association; NT-proBNP, N-Terminal pro Brain Natriuretic Peptide; BI, Barthel Index; CR, Cardiac Rehabilitation; CONUT, Controlling Nutritional Status.

lymphocyte count, components of CONUT, are affected by metabolic stress in the acute phase [36] and may not adequately reflect nutritional status in the acute phase. Another contributing factor might be the difference in the half-lives of albumin and prealbumin in the blood. Albumin has a half-life of approximately 20 days, whereas prealbumin has a half-life of approximately two days [11]. Therefore, albumin levels may not adequately reflect nutritional risk in the acute phase. In conclusion, prealbumin level may be a better predictor of ADL at discharge than CONUT score or albumin level in patients with acute HF.

The present study showed that the addition of prealbumin to the previously mentioned covariates [19–25] improved the model fit. Early implementation of physical and cognitive function measures may be limited by the risk of HF exacerbation associated with HF symptoms such as dyspnea and fatigue, and cardiac stress during measurement. Prealbumin is an objective indicator that can be measured without the effects of HF symptoms or the risk of HF exacerbation. Therefore, prealbumin may be a useful indicator for the early prediction of ADL at hospital discharge.

This study had four limitations. First, as this was a single-center study, the baseline characteristics of the participants may have been biased. Therefore, the generalizability of our results should be carefully considered. Second, because this was a retrospective study, the pre-admission prealbumin levels were not known. Therefore, the change in prealbumin levels from pre-admission to admission may have influenced the improvement in ADL. Third, prealbumin level was a predictor of ADL in this study, but the extent of inflammatory cytokines and skeletal muscle proteolysis was not assessed; therefore, the causal relationship between inflammation and changes in skeletal muscle catabolism and mass is unknown. Fourth, prealbumin is not a basic laboratory test in initial medical care [37] and may not be assessed in routine practice. Assessment of fast-turnover proteins, as typified by prealbumin, is relatively common in the recovery phase but not in the acute phase [38]. Owing to these limitations, there is a need to build evidence from multi-center prospective cohort studies and randomized controlled trials investigating the association between nutritional therapy for inflammation and ADL and to raise awareness of the importance of nutritional assessment in the acute rehabilitation setting in the future.

Conclusion

Prealbumin levels may be useful in predicting ADL at discharge in older patients with HF who are not ADL independent on admission.

References

1. Kaku H, Funakoshi K, Ide T, Fujino T, Matsushima S, Ohtani K, et al. Impact of hospital practice factors on mortality in patients hospitalized for heart failure in Japan—an analysis of a large number of health records from a nationwide claims-based database, the JROAD-DPC. Circ J 2020; 84: 742–53.
2. Shimokawa H, Miura M, Nochioka K, Sakata Y. Heart failure as a general pandemic in Asia. Eur J Heart Fail 2015; 17: 884–92.
3. Narumi T, Arimoto T, Funayama A, Kadowaki S, Otaki Y, Nishiyama S, et al. The prognostic importance of objective nutritional indexes in patients with chronic heart failure. J Cardiol 2016; 62: 307–13.
4. Katano S, Hashimoto A, Ohori K, Watanabe A, Honma R, Yanase R, et al. Nutritional status and energy intake as predictors of functional status after cardiac rehabilitation in elderly inpatients with heart failure—a retrospective cohort study—. Circ J 2018; 82: 1584–91.
5. Makita S. JCS/JACR 2021 Guideline on Rehabilitation in Patients with Cardiovascular Disease. Available from: https://www.j-circ.or.jp/cms/wp-content/uploads/2021/03/JCS2021_Makita.pdf (cited 2022 Aug 24). Japanese.
6. Ignacio de Ulíbarri J, González-Madroño A, de Villar NG, González P, González B, Mancha A, et al. CONUT: a tool for controlling nutritional status. Nutr Hosp 2005; 20: 38–45.
7. Kojima I, Tanaka S, Otobe Y, Suzuki M, Koyama S, Kimura Y, et al. What is the optimal nutritional assessment tool for predicting decline in the activity of daily living among older patients with heart failure? Heart Vessels 2022; 37: 1356–62.
8. Yokota J, Endo R, Takahashi R, Matsukawa Y, Matsushima K. Dysphagia and malnutrition limit activities of daily living improvement in phase i cardiac rehabilitation: a prospective cohort study for acute phase heart failure patients. Heart Vessels 2021; 36: 1306–16.
9. Evans DC, Corkins MR, Malone A, Miller S, Mogensen KM, Guenter P, et al. The use of visceral proteins as nutrition markers: an ASPEN position paper. Nutr Clin Pract 2021; 36: 22–8.
10. Saitoh M, Rodrigues Dos Santos M, von Haehling S. Muscle wasting in heart failure: the role of nutrition. Wien Klin Wochenschr 2016; 128: 455–65.
11. Spiekerman AM. Nutritional assessment (protein nutriture). Anal Chem 1995; 67: 429–36.
12. Obata H, Izumi T, Yamashita M, Mitsuma W, Suzuki K, Noto S, et al. Characteristics of elderly patients with heart failure and impact on activities of daily living: a registry report from Super-Aged Society. J Card Fail 2021; 27: 1203–13.
13. Mahoney FI, Barthel DW. Functional evaluation: the Barthel Index. Md State Med J 1965; 14: 61–5.
14. Kay R, Wong KS, Perez G, Woo J. Dichotomizing stroke outcomes based on self-reported dependency. Neurology 1997; 49: 1694–6.
15. Yancy CW, Jessup M, Bozkurt B, Butler J, Casey DE Jr,

Drazner MH. 2013 ACCF/AHA Guideline for the Management of Heart Failure: A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. Circulation 2013; 128: 240–327.
16. Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol 1994; 49: 85–94.
17. Rantanen T, Masaki K, Foley D, Izmirlian G, White L, Guralnik JM. Grip strength changes over 27 yr in Japanese-American men. J Appl Physiol 1998; 85: 2047–53.
18. Cohen J. Statistical Power Analysis for the Behavioral Sciences. 2nd ed, New York: Lawrence Erlbaum Associates; 1998.
19. Kitamura M, Izawa KP, Taniue H, Mimura Y, Imamura K, Nagashima H, et al. Relationship between activities of daily living and readmission within 90 days in hospitalized elderly patients with heart failure. BioMed Res Int 2017; 1–7.
20. Dunlay SM, Manemann SM, Chamberlain AM, Cheville AL, Jiang R, Weston SA, et al. Activities of daily living and outcomes in heart failure. Circ Heart Fail 2015; 8: 261–67.
21. Sasanuma N, Takahashi K, Itani Y, Tanaka T, Yamauchi S, Mabuchi S, et al. Motor and cognitive function analysis for home discharge using the Functional Independence Measure in patients undergoing cardiac rehabilitation at a long-term acute-care hospital. Eur J Phys Rehabil Med 2015; 51: 781–92.
22. Snipelisky D, Kelly J, Levine JA, Koepp GA, Anstrom KJ, McNulty SE, et al. Accelerometer-measured daily activity in heart failure with preserved ejection fraction: clinical correlates and association with standard heart failure severity indices. Circ Heart Fail 2017; 10: e003878.
23. Sansone GR, Alba A, Frengley JD. Analysis of FIM instrument scores for patients admitted to an inpatient cardiac rehabilitation program. Arch Phys Med Rehabil 2002; 83: 506–12.
24. Volpato S, Cavalieri M, Sioulis F, Guerra G, Maraldi C, Zuliani G, et al. Predictive value of the Short Physical Performance Battery following hospitalization in older patients. J Gerontol A Biol Sci Med Sci 2011; 66: 89–96.
25. Izawa KP, Watanabe S, Osada N, Kasahara Y, Yokoyama H, Hiraki K, et al. Handgrip strength as a predictor of prognosis in Japanese patients with congestive heart failure. Eur J Cardiovasc Prev Rehabil 2009; 16: 21–27.
26. Hazra A, Gogtay N. Biostatistics Series Module 6: Correlation and Linear Regression. Indian J Dermatol 2016; 61: 593–601.
27. Nojiri S, Itoh H, Kasai T, Fujibayashi K, Saito T, Hiratsuka Y, et al. Comorbidity status in hospitalized elderly in Japan: Analysis from National Database of Health Insurance Claims and Specific Health Checkups. Sci Rep 2019; 9: 20237.
28. Karlsen A, Mackey AL, Suetta C, Kjaer M. What is the impact of acute inflammation on muscle performance in geriatric patients? Exp Gerontol 2020; 138: 111008.
29. Tuttle CSL, Thang LAN, Maier AB. Markers of inflammation and their association with muscle strength and mass: a systematic review and meta-analysis. Ageing Res Rev 2020; 64: 101185.
30. Lavine KJ, Sierra OL. Skeletal muscle inflammation and atrophy in heart failure. Heart Fail Rev 2017; 22: 179–89.
31. Murphy SP, Kakkar R, McCarthy CP, Januzzi JL Jr. Inflammation in Heart Failure: JACC State-of-the-Art Review. J Am Coll Cardiol 2020; 75: 1324–40.
32. Belizário JE, Fontes-Oliveira CC, Borges JP, Kashiabara JA, Vannier E. Skeletal muscle wasting and renewal: a pivotal role of myokine IL-6. Springerplus 2016; 5: 619.
33. Koshikawa M, Harada M, Noyama S, Kiyono K, Motoike Y, Nomura Y, et al. Association between inflammation and skeletal muscle proteolysis, skeletal mass and strength in elderly heart failure patients and their prognostic implications. BMC Cardiovasc Disord 2020; 20: 228.
34. Jensen GL, Bistrian B, Roubenoff R, Heimburger DC. Malnutrition syndromes: a conundrum vs continuum. JPEN J Parenter Enteral Nutr 2009; 33: 710–6.
35. Izawa KP, Watanabe S, Oka K, Mogamiya T, Tada M, Nakata S, et al. Differences in physical performance based on the Geriatric Nutritional Risk Index in elderly female cardiac patients. Aging Clin Exp Res 2015; 27: 195–200.
36. Zhang Z, Pereira SL, Luo M, Matheson EM. Evaluation of blood biomarkers associated with risk of malnutrition in older adults: a systematic review and meta-analysis. Nutrients 2017; 9: 829.
37. Japanese Society of Laboratory Medicine Guideline Development Committee. Clinical Laboratory Guideline JSLM 2021. Available from:https://www.jslm.org/books/guideline/2021/GL2021_01.pdf (cited 2022 Nov 28). Japanese.
38. Medical Division Health Insurance Bureau Ministry of Health Labour and Welfare. Summary of Revision of Medical Fees for FY2022（Nutrition). Available from: https://www.mhlw.go.jp/content/10900000/001003511.pdf (cited 2022 Nov 28). Japanese.