Prognostic Impact of the Preservation of Activities of Daily Living on Post-Discharge Outcomes in Patients With Acute Heart Failure

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**Background:** Hospitalization for heart failure (HF) carries a risk of impairment in physical activity. We assessed the association between changes in Barthel index (BI) during hospitalization and prognosis in patients with acute HF.

**Methods and Results:** We evaluated the BI in 256 patients with acute HF at the time of hospital admission (pre-BI) and at discharge (post-BI). All patients were followed for 1 year after discharge. BI significantly decreased during hospitalization in enrolled patients. Patients with a post-BI <60 had longer hospital stays and higher rates of non-home discharge, and had a lower 1-year survival rate than those with a post-BI ≥60. Multivariate Cox regression analysis revealed that post-BI, not pre-BI or changes in BI, significantly correlated with all-cause death and the composite of all-cause death or rehospitalization for HF for 1 year after discharge. Patients with decreasing BI during hospitalization had significantly lower all-cause death- or HF readmission-free survival following acute HF than those having a pre-BI ≥60 and changes in BI ≥0.

**Conclusions:** Results demonstrate that low BI at discharge and decreased BI during hospitalization predicted poor outcomes in Japanese patients with acute HF. A comprehensive approach, beginning in the acute phase, aiming to maintain patients’ ability to perform activities of daily living could provide better management of HF.

**Key Words:** Acute heart failure; Barthel index; Prognosis
and 48 patients with no data for BI at either admission or at discharge were excluded. Informed consent was given by each patient, and the study was approved by the hospital ethics committee.

A medical history was obtained to document past medical history, medications, and comorbid disease. Hypertension was defined as systolic blood pressure (BP) ≥140 mmHg or diastolic BP ≥90 mmHg on repeated measurements, or administration of antihypertensive treatment. Diabetes mellitus was defined according to the diagnostic criteria of the Japan Diabetes Society. Dyslipidemia was defined as total cholesterol ≥220 mg/dL, triglycerides ≥150 mg/dL, low-density lipoprotein cholesterol ≥140 mg/dL, high-density lipoprotein cholesterol <40 mg/dL, or administration of lipid-lowering therapy.

**BI**

The BI is a 10-item scale to measure the functional ability to perform basic ADL. The items can be divided into 2 groups: those related to self-care (feeding, grooming, bathing, dressing, bowel and bladder care, and toilet use) and those related to mobility (ambulation, transfers, and stair climbing). The score ranges from zero, representing a totally dependent bedridden state, to 100, which represents complete independence. In the present study, the BI was obtained by trained nurses at admission and at discharge. The pre-BI was also evaluated on the basis of an interview performed before hospital admission, as in a previous study. Post-BI was defined as BI measured at discharge. The cutoff BI value used to divide patients into 2 groups was 60, in accordance with a previous study that demonstrated the contribution of severe functional dependence, while BI <60 aided in determination of the prognosis in patients with acute HF. Change in BI during hospitalization was calculated as the difference between pre-BI and post-BI.

**Biomarker Analysis and Echocardiography**

Blood samples were obtained at the time of hospital admission and at discharge. Complete blood counts were performed in a Sysmex XE-5000 analyzer (Sysmex, Kobe, Japan). Plasma B-type natriuretic peptide (BN) was measured with the AIA-2000 enzymatic immunoassay analyzer (TOSOH, Tokyo, Japan). Other biomarkers were measured using a LABOSPECT 008 autoanalyzer (Hitachi Co., Tokyo, Japan). Estimated glomerular filtration rate (eGFR) was calculated by the Modification of Diet in Renal Disease formula. Echocardiographic examination was performed by an experienced sonographer using Vivid E9 with XD clear (GE Healthcare, Tokyo, Japan). The images were stored in the console and analyzed offline. Left ventricular ejection fraction (LVEF) was calculated using the modified Simpson’s rule.

**Follow-up and Assessment of Clinical Outcomes**

All patients regularly visited the clinic (typically monthly) and were followed for 1 year after discharge. All-cause death was defined as any death occurring after discharge. Cardiac-related death was defined as the composite of HF, myocardial infarction, or sudden death from clinically suspected coronary artery disease based on clinical examination. HF readmission was defined as admission for worsening HF, diagnosed using Framingham criteria. Each clinical endpoint was adjudicated by experienced cardiologists who reviewed the medical records.

**Statistical Analysis**

All analyses were performed using PASW Statistics 21 software (SPSS Inc., Chicago, IL, USA). Continuous

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**Table 1. Baseline Characteristics of Patients With Acute HF (n=256)**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pre-BI, n (%)</th>
<th>Post-BI, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years), mean±SD</td>
<td>75.4±13.2</td>
<td>75.4±13.2</td>
</tr>
<tr>
<td>Male sex (%)</td>
<td>141 (55.1)</td>
<td>141 (55.1)</td>
</tr>
<tr>
<td>History of HF (%)</td>
<td>87 (40.0)</td>
<td>87 (40.0)</td>
</tr>
<tr>
<td>History of CAD (%)</td>
<td>44 (17.2)</td>
<td>44 (17.2)</td>
</tr>
<tr>
<td>BMI (kg/m²), mean±SD</td>
<td>24.1±5.9</td>
<td>24.1±5.9</td>
</tr>
<tr>
<td>Length of hospital stay (days), median (IQR)</td>
<td>12 (8–19)</td>
<td>12 (8–19)</td>
</tr>
<tr>
<td>Hypertension (%)</td>
<td>188 (73.4)</td>
<td>188 (73.4)</td>
</tr>
<tr>
<td>Diabetes mellitus (%)</td>
<td>105 (41.0)</td>
<td>105 (41.0)</td>
</tr>
<tr>
<td>Atrial fibrillation (%)</td>
<td>116 (45.3)</td>
<td>116 (45.3)</td>
</tr>
<tr>
<td>Systolic BP (mmHg), mean±SD</td>
<td>147.6±36.4</td>
<td>147.6±36.4</td>
</tr>
<tr>
<td>Hemoglobin (g/dL), mean±SD</td>
<td>12.1±2.5</td>
<td>12.1±2.5</td>
</tr>
<tr>
<td>CRP (mg/dL), median (IQR)</td>
<td>0.64 (0.15–2.57)</td>
<td>0.64 (0.15–2.57)</td>
</tr>
<tr>
<td>Albumin (g/dL), mean±SD</td>
<td>3.5±0.6</td>
<td>3.5±0.6</td>
</tr>
<tr>
<td>eGFR (mL/min/1.73m²), mean±SD</td>
<td>49.5±25.7</td>
<td>49.5±25.7</td>
</tr>
<tr>
<td>Sodium (mEq/L), mean±SD</td>
<td>138.8±4.0</td>
<td>138.8±4.0</td>
</tr>
<tr>
<td>BNP (pg/mL), median (IQR)</td>
<td>741.1 (399.5–1,384.5)</td>
<td>741.1 (399.5–1,384.5)</td>
</tr>
<tr>
<td>LVEF (%), mean±SD</td>
<td>43.7±16.8</td>
<td>43.7±16.8</td>
</tr>
<tr>
<td>Medications at discharge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACEI/ARB (%)</td>
<td>135 (52.7)</td>
<td>135 (52.7)</td>
</tr>
<tr>
<td>β-blocker (%)</td>
<td>179 (69.9)</td>
<td>179 (69.9)</td>
</tr>
<tr>
<td>Diuretic (%)</td>
<td>221 (86.3)</td>
<td>221 (86.3)</td>
</tr>
<tr>
<td>Mineralocorticoid receptor blocker (%)</td>
<td>128 (48.4)</td>
<td>128 (48.4)</td>
</tr>
<tr>
<td>Tolvaptan (%)</td>
<td>89 (34.8)</td>
<td>89 (34.8)</td>
</tr>
</tbody>
</table>

ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin-receptor blocker; BI, Barthel index; BMI, body mass index; BNP, B-type natriuretic peptide; BP, blood pressure; CAD, coronary artery disease; CRP, C-reactive protein; eGFR, estimated glomerular filtration rate; HF, heart failure; IQR, interquartile range; LVEF, left ventricular ejection fraction; NYHA, New York Heart Association.
variables are presented as the mean± standard deviation or median (interquartile range). Categorical variables are presented as the count and/or percentage. Student’s t-test or the Mann-Whitney U-test was used for group comparisons. Univariate correlations between pre-BI and other variables were investigated using the Spearman rank correlation test, and then multiple linear regression analysis was performed. The time-to-event incidence of the clinical outcome was determined using Kaplan-Meier analysis and the log-rank test, and Cox proportional hazard models were applied to determine independent predictors of clinical outcomes. To identify the covariates associated with BI decrease during hospitalization, logistic regression analysis was conducted. Variables with P<0.1 in the univariate analysis were incorporated into the multivariable model. Multivariate analysis with stepwise selection was performed. In all analyses, P<0.05 was considered statistically significant.

**Results**

**Baseline Characteristics**

A total of 256 patients with acute HF were enrolled in this study. Baseline characteristics of the patients are shown in Table 1. Patients were 75.4±13.2 years of age and 55.1% were male; 246 (96.1%) of patients were classified as New York Heart Association functional class III or IV. The actual pre-BI and post-BI values and the BI changes in patients with acute HF are shown in Table 2. The median pre-BI was 100 (80–100) and the median post-BI was 87.5 (55–100). The histograms of pre-BI and post-BI are shown in Figure S1. Age, male sex, history of HF, body mass index (BMI), hemoglobin, albumin, eGFR, and LVEF were found to be associated with pre-BI in the univariate analysis, and age, male sex, history of HF, and albumin were found to be significant in the multivariate analysis (Table S1). The mean change in BI was −8.6±20.7. The reduction in BI scores during hospitalization was significant (P<0.01). BI decreased in 43.4% and was unchanged in 43.8% of patients during hospitalization.

We compared the baseline characteristics between patients with post-BI <60 and post-BI ≥60 because patients with BI <60 were indicated to have functional dependency. There were 186 patients with post-BI ≥60 (72.7%), and 70 with post-BI <60 (27.3%). The post-BI <60 group was older, had a higher percentage of females, and had a lower mean BMI than the post-BI ≥60 group. Furthermore, the levels of hemoglobin and albumin were lower and the levels of C-reactive protein and BNP were higher in the post-BI <60 group than in the post-BI ≥60 group. Medications at discharge were comparable, other than the use of β-blockers (Table 3).

**Association Between Post-BI Scores and Clinical Outcomes**

We examined the association between post-BI scores and clinical outcomes in patients with acute HF. In this study, 9 patients were lost to follow-up after discharge. The post-BI <60 group required a longer hospital stay than the post-BI ≥60 group (median, 18.5 vs. 10 days; P<0.001). Furthermore, patients who required non-home discharge were more common in the post-BI <60 group (31.4%) than in the post-BI ≥60 group (2.7%) (P<0.01). During the year after discharge, there were 33 cases of all-cause death (12.9%) and 64 (25.0%) patients required rehospitalization.

<table>
<thead>
<tr>
<th>Table 3. Patients’ Characteristics According to Discharge BI Score (Post-BI)</th>
<th>Post-BI &lt;60 (n=70)</th>
<th>Post-BI ≥60 (n=186)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years), mean± SD</td>
<td>80.9±9.8</td>
<td>73.4±13.8</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Male sex (%)</td>
<td>25 (35.7)</td>
<td>116 (62.4)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>History of HF (%)</td>
<td>62 (44.2)</td>
<td>56 (30.1)</td>
<td>0.03</td>
</tr>
<tr>
<td>History of CAD (%)</td>
<td>12 (17.1)</td>
<td>32 (6.6)</td>
<td>0.99</td>
</tr>
<tr>
<td>BMI (kg/m2), mean± SD</td>
<td>22.4±3.9</td>
<td>24.6±6.3</td>
<td>0.01</td>
</tr>
<tr>
<td>Length of hospital stay (days), median (IQR)</td>
<td>18.5 (11–35.3)</td>
<td>10 (8–16)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Hypertension (%)</td>
<td>54 (77.1)</td>
<td>134 (72.0)</td>
<td>0.41</td>
</tr>
<tr>
<td>Diabetes mellitus (%)</td>
<td>24 (34.3)</td>
<td>81 (43.5)</td>
<td>0.18</td>
</tr>
<tr>
<td>Atrial fibrillation (%)</td>
<td>31 (44.3)</td>
<td>85 (45.7)</td>
<td>0.84</td>
</tr>
<tr>
<td>Systolic BP (mmHg), mean± SD</td>
<td>142.0±32.7</td>
<td>149.6±37.6</td>
<td>0.14</td>
</tr>
<tr>
<td>Hemoglobin (g/dL), mean± SD</td>
<td>12.1±2.5</td>
<td>12.3±2.6</td>
<td>0.02</td>
</tr>
<tr>
<td>CRP (mg/dL), median (IQR)</td>
<td>1.32 (0.27–4.02)</td>
<td>0.49 (0.14–2.41)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Albumin (g/dL), mean± SD</td>
<td>3.3±0.6</td>
<td>3.6±0.5</td>
<td>0.01</td>
</tr>
<tr>
<td>eGFR (mL/min/1.73 m2), mean± SD</td>
<td>47.1±29.0</td>
<td>50.4±24.3</td>
<td>0.36</td>
</tr>
<tr>
<td>Sodium (mEq/L), mean± SD</td>
<td>138.4±4.5</td>
<td>139.0±3.8</td>
<td>0.28</td>
</tr>
<tr>
<td>BNP (pg/mL), median (IQR)</td>
<td>761.4 (335.6–1,659.4)</td>
<td>706.1 (415.2–1,313.0)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>LVEF (%), mean± SD</td>
<td>45.6±15.8</td>
<td>43.0±17.1</td>
<td>0.28</td>
</tr>
</tbody>
</table>

Abbreviations as in Tables 1, 2.

**Medications at discharge**

<table>
<thead>
<tr>
<th></th>
<th>Post-BI &lt;60 (%)</th>
<th>Post-BI ≥60 (%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACEI/ARB (%)</td>
<td>31 (44.3)</td>
<td>104 (55.9)</td>
<td>0.10</td>
</tr>
<tr>
<td>β-blocker (%)</td>
<td>41 (58.6)</td>
<td>138 (74.2)</td>
<td>0.02</td>
</tr>
<tr>
<td>Diuretic (%)</td>
<td>62 (88.6)</td>
<td>159 (85.5)</td>
<td>0.52</td>
</tr>
<tr>
<td>Mineralocorticoid receptor blocker (%)</td>
<td>27 (38.6)</td>
<td>97 (52.2)</td>
<td>0.05</td>
</tr>
<tr>
<td>Tolvaptan (%)</td>
<td>18 (25.7)</td>
<td>71 (38.2)</td>
<td>0.06</td>
</tr>
</tbody>
</table>
levels of hemoglobin, albumin, and sodium. Among these factors, post-BI and albumin were found to be independent predictors of all-cause death in the multivariate Cox regression models (Table 4). Furthermore, we compared the clinical parameters associated with the incidence of all-cause death or HF readmission by single and multiple logistic regression analyses. Post-BI, change in BI, age, history of HF, BMI, hemoglobin level, albumin level, eGFR, and the use of angiotensin-converting enzyme inhibitors (ACEI)/angiotensin-receptor blockers (ARB) were found to be predictors of all-cause death or HF readmission in the univariate analysis. Post-BI, history of HF, and for deterioration of HF. Kaplan-Meier analysis revealed that all-cause death and the incidence of all-cause death and HF readmission after discharge were significantly higher in the post-BI <60 group than in the post-BI ≥60 group (Figure 1). Details of clinical outcomes during the year after discharge are shown in Table S2.

To determine factors associated with 1-year clinical outcomes after discharge in patients with acute HF, we compared the clinical parameters associated with all-cause death by single and multiple logistic regression analyses. Univariate Cox regression analyses revealed the following as significant factors: post-BI, change in BI, age, BMI; and

| Table 4. Predictors of All-Cause Death in Patients With Acute HF Based on Cox Regression Analyses |
|---------------------------------------------------------------|---------------------------------------------------------------|
| **Univariate** | **Multivariate** |
| **HR** | **95% CI** | **P value** | **HR** | **95% CI** | **P value** |
| Post-BI | 0.982 | 0.972–0.992 | <0.01 | 0.981 | 0.970–0.992 | <0.01 |
| Pre-BI | 0.986 | 0.975–0.998 | 0.02 | – | – | – |
| Change in BI | 0.983 | 0.969–0.997 | 0.02 | – | – | – |
| Age | 1.038 | 1.005–1.072 | 0.02 | – | – | – |
| Male sex | 0.770 | 0.389–1.523 | 0.17 | – | – | – |
| History of HF | 1.952 | 0.986–3.846 | 0.06 | – | – | – |
| BMI | 0.908 | 0.834–0.990 | 0.03 | – | – | – |
| Length of hospital stay | 1.018 | 1.007–1.030 | <0.01 | – | – | – |
| Hemoglobin | 0.822 | 0.718–0.940 | <0.01 | – | – | – |
| CRP | 1.046 | 1.000–1.095 | 0.05 | – | – | – |
| Albumin | 0.373 | 0.217–0.640 | <0.01 | 0.463 | 0.258–0.832 | 0.01 |
| eGFR | 0.993 | 0.979–1.007 | 0.35 | – | – | – |
| Sodium | 0.906 | 0.847–0.969 | <0.01 | – | – | – |
| BNP (per 100 pg/mL) | 1.018 | 0.985–1.819 | 0.29 | – | – | – |
| LVEF | 1.001 | 0.981–1.053 | 0.94 | – | – | – |
| ACEI/ARB | 0.614 | 0.308–1.224 | 0.17 | – | – | – |
| β-blocker | 1.123 | 0.507–2.491 | 0.78 | – | – | – |
| Mineralcorticoid receptor blocker | 0.555 | 0.273–1.129 | 0.10 | – | – | – |

CI, confidence interval; HR, hazard ratio. Other abbreviations as in Tables 1, 2.

Figure 1. Kaplan-Meier estimates of (A) survival rate and (B) all-cause death or heart failure (HF) rehospitalization-free survival rate. The pre-Barthel index (BI) was evaluated on the basis of an interview with patients or their families 15 days prior to admission. Post-BI was defined as BI measured at discharge. The cutoff value of the BI to divide patients into 2 groups was determined to be 60, which has been reported as the value of functional dependency.
ADL and Acute HF

Analysis for the incidence of all-cause death or HF readmission during the year after discharge. Groups 2 and 4, but not group 3, had worse all-cause death- or HF readmission-free survival than group 1 (group 1 vs. group 2: \( P=0.04 \), group 1 vs. group 3: \( P=0.07 \), group 1 vs. group 4: \( P<0.01 \)). Thus, decreased BI during hospitalization was associated with poor prognosis after discharge.

Discussion

The current study demonstrated that, in patients with acute HF, BI at discharge independently predicted subsequent poor prognosis. BI score at discharge also showed a higher statistical association with 1-year clinical outcomes than the BI score prior to admission and changes in BI during hospitalization. BMI, and use of ACEI/ARB were found to be significant independent predictors in the multivariate analysis (Table 5). Thus, post-BI was the only independent predictor of both all-cause death and the incidence of all-cause death or HF readmission (Tables 4, 5).

**Effect of ADL Decline During HF Hospitalization on Prognosis**

Finally, we investigated the effect of changes in BI during hospitalization in combination with pre-BI scores. We divided patients into 4 groups: group 1, with pre-BI \( \geq 60 \) and change in BI \( \geq 0 \) (n=123); group 2, with pre-BI \( \geq 60 \) and change in BI \( <0 \) (n=81); group 3, with pre-BI \( <60 \) and change in BI \( \geq 0 \) (n=23); and group 4, with pre-BI \( <60 \) and change in BI \( <0 \) (n=29). Figure 2 shows the Kaplan-Meier analysis for the incidence of all-cause death or HF readmission during the year after discharge. Groups 2 and 4, but not group 3, had worse all-cause death- or HF readmission-free survival than group 1 (group 1 vs. group 2: \( P=0.04 \), group 1 vs. group 3: \( P=0.07 \), group 1 vs. group 4: \( P<0.01 \)). Thus, decreased BI during hospitalization was associated with poor prognosis after discharge.

**Table 5. Predictors of the Incidence of All-Cause Death or Readmission for HF Based on Cox Regression Analyses**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Univariate</th>
<th></th>
<th></th>
<th></th>
<th>Multivariate</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HR</td>
<td>95% CI</td>
<td>P value</td>
<td>HR</td>
<td>95% CI</td>
<td>P value</td>
<td></td>
</tr>
<tr>
<td>Post-BI</td>
<td>( 0.986 )</td>
<td>( 0.979--0.992 )</td>
<td>&lt;0.01</td>
<td>( 0.987 )</td>
<td>( 0.979--0.995 )</td>
<td>&lt;0.01</td>
<td></td>
</tr>
<tr>
<td>Pre-BI</td>
<td>( 0.987 )</td>
<td>( 0.980--0.995 )</td>
<td>&lt;0.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in BI</td>
<td>( 0.989 )</td>
<td>( 0.979--0.999 )</td>
<td>0.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>( 1.034 )</td>
<td>( 1.014--1.055 )</td>
<td>&lt;0.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male sex</td>
<td>( 0.961 )</td>
<td>( 0.621--1.486 )</td>
<td>0.86</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>History of HF</td>
<td>( 2.368 )</td>
<td>( 1.534--3.654 )</td>
<td>&lt;0.01</td>
<td>( 1.806 )</td>
<td>( 1.124--2.901 )</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>( 0.906 )</td>
<td>( 0.857--0.958 )</td>
<td>&lt;0.01</td>
<td>( 0.940 )</td>
<td>( 0.887--0.996 )</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>Length of hospital stay</td>
<td>( 1.011 )</td>
<td>( 1.002--1.020 )</td>
<td>&lt;0.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemoglobin</td>
<td>( 0.882 )</td>
<td>( 0.808--0.962 )</td>
<td>0.01</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>CRP</td>
<td>( 1.013 )</td>
<td>( 0.975--1.052 )</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Albumin</td>
<td>( 0.574 )</td>
<td>( 0.402--0.820 )</td>
<td>&lt;0.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>eGFR</td>
<td>( 0.903 )</td>
<td>( 0.981--0.999 )</td>
<td>0.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td>( 0.960 )</td>
<td>( 0.914--1.008 )</td>
<td>0.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BNP (per 100 pg/mL)</td>
<td>( 1.020 )</td>
<td>( 0.999--1.042 )</td>
<td>0.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LVEF</td>
<td>( 0.996 )</td>
<td>( 0.983--1.009 )</td>
<td>0.52</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACEI/ARB</td>
<td>( 0.555 )</td>
<td>( 0.358--0.862 )</td>
<td>0.01</td>
<td>( 0.573 )</td>
<td>( 0.358--0.918 )</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>( \beta )-blocker</td>
<td>( 1.267 )</td>
<td>( 0.759--2.117 )</td>
<td>0.37</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mineralocorticoid receptor blocker</td>
<td>( 0.751 )</td>
<td>( 0.485--1.161 )</td>
<td>0.20</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Abbreviations as in Tables 1, 2, 4.
hospitalization. Efforts to preserve patients’ ability to perform ADL during HF hospitalization could be important for the management of HF.

The BI has been shown to have greater sensitivity to change and these scores may detect the onset of disability earlier than other scores.22 The BI data were sufficient to determine the inter-rater reliability; the reliability and validity were determined according to the method of assessment (face-to-face or an interview with either the patient or caregiver). However, only a few studies have investigated the change in BI during hospitalization for acute illness other than HF. In 1 prospective study investigating the functional status of healthy elderly patients who entered the medical intensive care unit, the average BI was 96.3±8.8 before admission and 69.8±29.2 at discharge.23 BI in female patients with hip fractures was 100 (95–100) before admission and 55 (40–65) at discharge from an orthopedic ward.24 BI before admission seems to be lower in HF than in other acute illnesses, possibly because of the prolonged clinical course of HF. BI at discharge may be affected by the age of the study population, the disease severity, and the influence of the disease on the decline in ADL.

Various factors associated with the pathophysiology and treatment of HF; including cardiopulmonary insufficiency, bed rest, myopathy, and malnutrition, are considered to cause and exacerbate muscle weakness, leading to limited exercise tolerance and decline in the ability to perform ADL. Several studies have demonstrated that BI scores frequently decreased 1 year after hospitalization in patients with HF.25 In the present study, hospitalization for HF was significantly correlated with decreased BI, and decreased BI during hospitalization was associated with worse clinical outcomes, especially in patients with pre-BI ≥60. Disease severity, patient frailty, and insufficient use of rehabilitation might contribute to the BI decrease during hospitalization and could explain the effect of decreasing BI on prognosis.

Several approaches to maintaining functional status have been reported for patients with HF. First, early and intensive rehabilitation could preserve physical performance and functional capacity.28–30 Second, medications to rapidly improve decongestion lead to early ambulation and ADL preservation.31,32 Third, as our data demonstrated that the albumin level at admission was a predictor of all-cause death, nutritional support might be a key strategy (Table 4). Finally, other approaches, such as educational programs and guideline-based therapy to improve HF prognosis, could contribute to preservation of the ability to perform ADL.31,32 Taken together, we should recognize the importance of a multidisciplinary team approach to preserving HF patients’ ability to perform ADL.

Poor physical performance and functional disability are frequent in patients with HF. Less ability to perform ADL levels is associated with increased social or caregiver support, the development of mood disorders, and reduced quality of life.33–35 ADL performance level can be regarded as a reflection of biological age. We showed that BI scores are an independent predictor of clinical outcomes after adjusting for various parameters, including age, in multivariable models. These findings indicate the importance of ADL, and of biological age rather than actual age in the management of HF.

Several studies have assessed the association between BI prior to admission and the clinical outcomes of patients with HF. BI or functional disability prior to admission has been shown to be associated with poor prognosis in patients with HF.36 However, most previous studies have reported the association between BI prior to admission and short-term death, including in-hospital death. In the present study, we showed that post-BI, but not pre-BI, was a significant prognostic predictor of long-term clinical outcomes after discharge.

Study Limitations
First, this was a single-center, retrospective study, and the sample size was relatively small. Future prospective studies with a larger patient population are necessary. Second, we did not measure cognitive impairment, comorbidities, or social aspects, which may also be associated with patients’ ability to perform ADL. Third, we did not limit the enrollment of patients to the elderly. Because most studies of ADL have enrolled elderly patients, age and age-related factors, including BMI, might have had some influence on the results.

Conclusions
Our findings suggested that low BI at discharge and decrease in BI during hospitalization predict poor outcomes in Japanese patients with acute HF. A comprehensive approach, beginning in the acute phase, aiming to maintain patients’ ability to perform ADL could provide better management of acute HF.

Acknowledgments
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References


Supplementary Files

Supplementary File 1

Figure S1. Histograms of (A) pre-BI and (B) post-BI scores.

Table S1. Independent predictors of pre-BI based on multiple logistic regression analysis

Table S2. Details of clinical outcomes during 1 year after discharge