ORIGINAL ARTICLE

# Inaccurate recognition of own comorbidities is associated with poor prognosis in elderly patients with heart failure

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## Abstract

**Aims**   A patient's understanding of his or her own comorbidities is part of the recommended patient education for those with heart failure. The accuracy of patients' understanding of their comorbidities and its prognostic impact have not been reported.

**Methods and results**   Patients hospitalized for heart failure ($n$ = 1234) aged ≥65 years (mean age: 80.1 ± 7.7 years; 531 females) completed a questionnaire regarding their diagnoses of diabetes, malignancy, stroke, hypertension, chronic obstructive pulmonary disease (COPD), and coronary artery disease (CAD). The patients were categorized into three groups based on the number of agreements between self-reported comorbidities and provider-reported comorbidities: low (1–2, $n$ = 19); fair (3–4, $n$ = 376); and high (5–6, $n$ = 839) agreement groups. The primary outcome was a composite of all-cause mortality or heart failure rehospitalization at 1 year. The low agreement group had more comorbidities and a higher prevalence of a history of heart failure. The agreement was good for diabetes ($\kappa$ = 0.73), moderate for malignancy ($\kappa$ = 0.56) and stroke ($\kappa$ = 0.50), and poor-to-fair for hypertension ($\kappa$ = 0.33), COPD ($\kappa$ = 0.25), and CAD ($\kappa$ = 0.30). The fair and low agreement groups had poorer outcomes than the good agreement group [fair agreement group: hazard ratio (HR): 1.25; 95% confidence interval (CI): 1.01–1.56; $P$ = 0.041; low agreement group: HR: 2.74: 95% CI: 1.40–5.35; $P$ = 0.003].

**Conclusions**   The ability to recognize their own comorbidities among older patients with heart failure was low. Patients with less accurate recognition of their comorbidities may be at higher risk for a composite of all-cause mortality or heart failure rehospitalization.

## Introduction

Heart failure is one of the leading global causes of public health concerns and mortality. As heart failure is strongly associated with older age, cardiac and non-cardiac comorbidities are prevalent in patients with heart failure.[1–3] Recent studies have reported that the number of comorbidities in patients with heart failure increases over time and that the presence of more comorbidities is associated with higher mortality.[4]

Patient education is key to prevent disease progression and provide better disease management. The American College of Cardiology Foundation and the American Heart Association guidelines and European Society of Cardiology guidelines for heart failure recommend providing adequate patient education that allows the patient to better understand heart failure as a disease and perform self-care, including symptom monitoring.[5,6] The understanding and recognition of one's own comorbidities is an essential and fundamental aspect of patient education.[7] Studies on the general population,[1–3,8,9] patients with cancer,[10–12] and patients with chronic kidney disease[13,14] have reported that patients do not necessarily recognize their own comorbid conditions that are recorded in their medical records and that the agreement between self-reported and provider-reported comorbidities is generally poor. The accuracy of self-reported comorbidities among patients with heart failure has not been reported. A poor understanding or recognition of comorbid conditions may be associated with a poor prognosis, based on previous studies that have suggested that better self-care behaviour reduces heart failure hospitalizations and the mortality rate in patients with heart failure[15,16]; however, study has investigated the association between the patient's awareness of his or her own comorbidities and the prognosis in any patient population. Therefore, in this study, we investigated the agreement between self-reported and provider-reported comorbidities, the predictive factors for the disagreement between the reported comorbidities, and the association between the agreement and prognosis in older patients with heart failure.

## Methods

### Study design

This study is a post hoc analysis of data from the FRAGILE-HF study, which was a prospective, multicentre, observational study that evaluated the prevalence and prognostic value of physical, social, and cognitive frailty in older patients hospitalized for heart failure. The detailed study design and results of the FRAGILE-HF study have been published elsewhere.[17–19] In brief, 1332 patients aged ≥65 years hospitalized for heart failure, who could walk alone at discharge, were enrolled from 15 hospitals in Japan between September 2016 and March 2018. The diagnosis of heart failure was based on the Framingham criteria.[20] Patients with a previous heart transplantation or left ventricular assist device implantation, chronic peritoneal dialysis or haemodialysis, or acute myocarditis were excluded.

This study was conducted according to the principles of the Declaration of Helsinki and the Japanese Ethical Guidelines for Medical and Health Research involving Human Subjects. All patients were notified regarding their participation in our study and were provided the opportunity to opt out. As this was an observational study without invasive interventions, written informed consent was not required, as per the Ethical Guidelines for Medical and Health Research Involving Human Subjects, issued by the Japanese Ministry of Health, Labor, and Welfare. The study protocol was approved by the Sakakibara Heart Institution of Okayama Research Ethics Committee. The study information such as aims, inclusion and exclusion criteria, primary endpoint, and participating hospitals have been published in the publicly available University Hospital Information Network (UMIN-CTR, unique identifier: UMIN000023929).

### Data collection

Physical examination, echocardiography, blood tests, and oral medication data were collected when the patients were in a clinically compensated state, prior to discharge. A history of heart failure was defined as having been diagnosed with heart failure before index hospitalization. Cognitive function was evaluated using the Mini-Cog test, on which scores ≤ 2 points were defined as cognitive dysfunction.[21]

In the FRAGILE-HF study, the investigators reported the presence or absence of six comorbidities (hypertension, diabetes, cancer, chronic lung disease, coronary artery disease, and stroke) for all patients on a case report form (CRF). These six comorbidities are included in the Frail Scale questionnaire[19,22] as the following question: 'Did a doctor ever tell you that you have [disease]?'.[22,23] All patients in the FRAGILE-HF study completed the Frail Scale questionnaire.

### Outcomes

One-year outcomes were prospectively collected in the FRAGILE-HF study. The predetermined primary outcome included all-cause mortality and heart failure rehospitalization, which was defined according to the American College of Cardiology/American Heart Association Key Data Elements and Definitions for Cardiovascular Endpoint Events in Clinical Trials.[24] Most study patients were followed up as outpatients

in clinics at least every 3 months and as medically needed. For patients who did not attend outpatient follow-up visits, clinical outcomes were collected via telephone interviews, medical records from other medical institutions, or interviews with the patients' families.

## Statistical analysis

Variables with normal distribution are presented as mean and standard deviation, and those with non-normal distribution are presented as median and interquartile range. Categorical variables are reported as numbers and percentages. Continuous data were compared using Student's $t$-tests or Mann–Whitney $U$ tests, and categorical data were compared using $\chi^2$ or Fisher's exact tests, as appropriate.

The agreement between the comorbidities reported by the patient and those included in the CRF was evaluated using Cohen's Kappa ($\kappa$) coefficient.[25] The classification of Landis and Koch was used to evaluate the agreement levels: poor-to-fair ($\kappa < 0.40$), moderate ($0.40 < \kappa \le 0.60$), substantial ($0.60 < \kappa \le 0.80$), and almost perfect ($0.80 < \kappa \le 1.00$).[25] The sensitivity (correctly self-reported 'Yes'/CRF 'Yes'), specificity (correctly self-reported 'No'/CRF 'No'), positive predictive value (correctly self-reported 'Yes'/all self-reported 'Yes'), negative predictive value (correctly self-reported 'No'/all self-reported 'No'), false-positive (incorrectly self-reported 'Yes'/CRF 'No'), false-negative (incorrectly self-reported 'No'/CRF 'Yes'), and overall agreement (correctly self-reported 'Yes' and 'No'/all answers) were calculated using the CRF-based presence or absence of comorbidities as a gold standard. False-positives were defined as over-reporting and false-negatives as under-reporting. The agreement score was defined as the number of comorbidities with agreement between the patient's report and the CRF. The agreement score was calculated for each patient and used to determine how accurately the patients recognized their own comorbidities. The agreement score ranged from 0 to 6. The patients were divided into three groups according to the agreement score: low agreement group (agreement score, 1–2), fair agreement group (agreement score, 3–4), and high agreement group (agreement score, 5–6). Group differences were evaluated using one-way analysis of variance or the Kruskal–Wallis test for continuous variables, and $\chi^2$ or Fisher's exact test for dichotomous variables, as appropriate.

Univariate and multivariable logistic regression analyses were used to identify patient characteristics related to the agreement of each comorbidity. A Kaplan–Meier analysis with a log-rank test was used to compare the prognosis between groups stratified by the agreement score into the following four groups: complete agreement (patients with agreement score of 6), patients with more under-reporting, patients with more over-reporting, and patients with equal

under-reporting and over-reporting. For example, patients who under-reported two comorbidities and over-reported one comorbidity were classified into the under-reporting group. Unadjusted and adjusted Cox proportional hazards analyses were performed to assess the association between clinical variables and prognosis. In adjusted Model 1, well-known prognostic factors for heart failure[17,19] were adjusted for, including age, sex, body mass index, New York Heart Association class III or IV at discharge, current smoking status, systolic blood pressure, prior history of heart failure, hypertension, diabetes mellitus, atrial fibrillation, coronary artery disease, chronic obstructive pulmonary disease (COPD), estimated glomerular filtration rate, haemoglobin, serum albumin, serum sodium, log-transformed brain natriuretic peptide, left ventricular ejection fraction, angiotensin-converting enzyme inhibitor or angiotensin receptor blocker prescriptions, beta-blocker prescriptions, and mineralocorticoid receptor antagonist prescriptions. In adjusted Model 2, the variables in Model 1 and the number of comorbidities and cognitive dysfunction were accounted for as these have also been reported to be risk factors for prognosis in patients with heart failure.[4,17]

Multiple imputation was used for the missing covariate data to construct multivariable Cox regression models. Twenty datasets were created using a chained-equations procedure.[26] Parameter estimates were obtained for each dataset and subsequently combined to produce an integrated result using the method described by Barnard and Rubin.[27]

All analyses were performed using R software Version 3.1.2 (R Foundation for Statistical Computing, Vienna, Austria; ISBN: 3-900051-07-0, URL: http://www.R-project.org). Statistical significance was set at $P < 0.05$.

## Results

Among the 1332 patients aged ≥65 years hospitalized for heart failure who were enrolled in the FRAGILE-HF study, 98 (7.4%) were excluded from this study due to missing data on the CRF or Frail Scale questionnaire. Therefore, the final analyses included 1234 patients, including 19 in the low agreement group, 376 in the fair agreement group, and 839 in the high agreement group. The patients' baseline characteristics are shown in *Table 1*. There were no differences in sex, left ventricular ejection fraction, oral medications, or laboratory data between the groups. More patients in the low agreement group had histories of diabetes, COPD, stroke, and heart failure. The number of comorbidities and the prevalence of cognitive dysfunction were lower in the high agreement group than in the other groups. The agreements of each comorbidity are described in *Table 2*. The $\kappa$ coefficient levels were poor-to-fair for hypertension ($\kappa = 0.33$), COPD ($\kappa = 0.25$), and coronary artery disease ($\kappa = 0.30$); moderate

**Table 1** Patient characteristics

|  | Low agreement group | Fair agreement group | High agreement group |  |
|---|---|---|---|---|
|  | *n* = 19 | *n* = 376 | *n* = 839 | *P*-value |
| Age (years) | 81 [74, 86] | 82 [76, 87] | 80 [74, 85] | <0.001 |
| Male sex, *n* (%) | 13 (68.4) | 221 (58.8) | 469 (55.9) | 0.39 |
| Living status, *n* (%) |  |  |  | 0.65 |
| Living with someone | 16 (84.2) | 276 (73.4) | 638 (76.0) |  |
| Living alone | 3 (15.8) | 84 (22.3) | 174 (20.7) |  |
| Living in a nursery home | 0 (0) | 16 (4.3) | 27 (3.2) |  |
| Currently smoking, *n* (%) | 2 (10.5) | 28 (7.5) | 87 (10.4) | 0.27 |
| NYHA class III/IV, *n* (%) | 4 (21.1) | 48 (12.8) | 121 (14.4) | 0.50 |
| Body mass index (kg/m$^2$) | 20.5 (2.6) | 21.4 (3.8) | 21.4 (3.8) | 0.60 |
| Systolic blood pressure (mmHg) | 112 (15) | 113 (16) | 114 (18) | 0.46 |
| Diastolic blood pressure (mmHg) | 61 (9) | 62 (11) | 62 (11) | 0.94 |
| Heart rate (b.p.m.) | 71 (11) | 71 (14) | 71 (14) | 0.78 |
| Left ventricular ejection fraction (%) | 47 (16) | 46 (17) | 46 (17) | 0.95 |
| Atrial fibrillation, *n* (%) | 14 (73.7) | 174 (46.3) | 355 (42.3) | 0.014 |
| Coronary artery disease, *n* (%) | 7 (36.8) | 165 (43.9) | 263 (31.3) | <0.001 |
| COPD, *n* (%) | 7 (36.8) | 68 (18.1) | 58 (6.9) | <0.001 |
| Diabetes, *n* (%) | 11 (57.9) | 150 (39.9) | 275 (32.8) | 0.007 |
| Hypertension, *n* (%) | 16 (84.2) | 265 (70.5) | 598 (71.3) | 0.44 |
| Malignancy, *n* (%) | 3 (15.8) | 68 (18.1) | 110 (13.1) | 0.066 |
| Stroke, *n* (%) | 8 (42.1) | 79 (21.0) | 77 (9.2) | <0.001 |
| Number of comorbidities | 2.7 (1.1) | 2.1 (1.1) | 1.6 (1.1) | <0.001 |
| Cognitive dysfunction, *n* (%) | 8 (42.1) | 163 (43.6) | 287 (34.4) | 0.008 |
| History of heart failure, *n* (%) |  |  |  | <0.001 |
| None | 6 (31.6) | 138 (36.7) | 411 (49.0) |  |
| Less than 1.5 years | 2 (10.5) | 75 (19.9) | 114 (13.6) |  |
| More than 1.5 years | 11 (57.9) | 163 (43.4) | 313 (37.4) |  |
| Prescription at discharge, *n* (%) |  |  |  |  |
| Loop diuretics | 13 (68.4) | 220 (58.5) | 455 (54.2) | 0.20 |
| ACE-I/ARB | 13 (68.4) | 254 (67.6) | 568 (67.7) | 0.99 |
| Beta-blocker | 15 (78.9) | 276 (73.4) | 608 (72.5) | 0.79 |
| MRA | 3 (15.8) | 26 (6.9) | 74 (8.8) | 0.27 |
| Laboratory data at discharge |  |  |  |  |
| Haemoglobin (g/dL) | 11.1 (1.2) | 11.7 (1.9) | 11.9 (2.1) | 0.10 |
| Albumin (g/dL) | 3.5 (0.3) | 3.4 (0.5) | 3.5 (0.5) | 0.29 |
| Creatinine (mg/dL) | 1.31 (0.63) | 1.44 (0.94) | 1.35 (0.78) | 0.24 |
| Blood urea nitrogen (mg/dL) | 23 [20, 29] | 27 [21, 37] | 26 [19, 35] | 0.15 |
| Sodium (mEq/L) | 138.8 (3.9) | 138.9 (4.0) | 139.0 (3.7) | 0.88 |
| Potassium (mEq/L) | 4.4 (0.5) | 4.4 (0.5) | 4.4 (0.5) | 0.80 |
| BNP (pg/mL) | 297.4 [101.7, 402.5] | 282.7 [139.0, 493.7] | 264.0 [132.4, 491.1] | 0.71 |

ACE-I, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; BNP, brain natriuretic peptide; COPD, chronic obstructive pulmonary disease; MRA, mineralocorticoid receptor antagonist; NYHA, New York Heart Association.
Variables are described as mean (standard deviation) or median [interquartile range].

**Table 2** Agreement between self-reported and provider-reported comorbidities

|  | Kappa | 95% CI | Sensitivity (%) | Specificity (%) | PPV (%) | NPV (%) | False negative (%) | False positive (%) | Overall agreement (%) |
|---|---|---|---|---|---|---|---|---|---|
| Hypertension | 0.33 | 0.27–0.38 | 69.0 | 68.2 | 84.4 | 47.1 | 31.0 | 31.7 | 68.8 |
| Diabetes | 0.73 | 0.69–0.77 | 77.7 | 93.9 | 87.4 | 88.5 | 22.3 | 6.1 | 88.1 |
| Malignancy | 0.56 | 0.50–0.63 | 68.6 | 91.7 | 58.8 | 94.4 | 31.4 | 8.3 | 88.3 |
| COPD | 0.25 | 0.15–0.35 | 32.6 | 92.1 | 33.1 | 91.9 | 67.4 | 7.9 | 85.7 |
| Coronary artery disease | 0.30 | 0.25–0.36 | 61.0 | 70.4 | 53.1 | 76.6 | 39.0 | 29.6 | 67.1 |
| Stroke | 0.50 | 0.42–0.57 | 63.6 | 90.9 | 51.5 | 94.3 | 36.4 | 9.1 | 87.4 |

CI, confidence interval; COPD, chronic obstructive pulmonary disease; NPV, negative predictive value; PPV, positive predictive value.

for malignancy ($\kappa$ = 0.56) and stroke ($\kappa$ = 0.50); and substantial for diabetes mellitus ($\kappa$ = 0.73). Overall, there was more under-reporting than over-reporting of all comorbidities except hypertension.

Older age was observed to be associated with lower levels of agreement for malignancy and coronary artery disease, and

a longer history of heart failure was associated with a lower level of agreement for hypertension and coronary artery disease (Supporting Information, *Table S1*). Cognitive dysfunction was also related to a lower level of agreement for hypertension. For 4/6 comorbidities, a greater number of comorbidities was associated with lower levels of agreement.

Among the 1234 study patients, 1210 (98.1%) were followed up until 1 year. The primary endpoint occurred in 402 patients (33.2%), including 10 patients (55.6%) in the low agreement group, 144 (39.3%) in the fair agreement group, and 248 (30.0%) in the high agreement group ($P < 0.001$, $P$ for trend = 0.002). Hospitalization for heart failure was observed in 202 (24.5%) patients in the high agreement group, 119 (32.7%) in the fair agreement group, and 8 (47.2%) in the low agreement group ($P = 0.003$, $P$ for trend $< 0.001$). All-cause mortality was observed in 88 (10.6%) patients in the high agreement group, 54 (14.8%) in the fair agreement group, and 3 (16.7%) in the low agreement group ($P = 0.108$, $P$ for trend = 0.036) (*Figure 1*). Lower agreement was associated with a higher incidence of the primary endpoint (*Figure 2*) (log-rank: $P < 0.001$). This association was retained even after adjustment for other factors related to the primary outcome, including cognitive dysfunction and number of comorbidities (*Table 3*). Patients who under-reported or over-reported their comorbidities were more likely to have a poor prognosis than those in the complete agreement group (Supporting Information, *Figure S1*). Furthermore, no difference in prognosis was observed between patients who under-reported, over-reported, or equally under-reported and over-reported their comorbidities in adjusted Model 2 (Supporting Information, *Table S2*).

## Discussion

The agreement between self-reported and provider-reported comorbidities is low among older patients with heart failure. The low agreement rate is more due to under-reporting than over-reporting by the patients. Patients with lower agree-

**Figure 1** Event rates of all-cause death or heart failure rehospitalization. Lower agreement level was associated with higher incidence of each all-cause death or heart failure rehospitalization. ACD, all-cause death; HFH, heart failure rehospitalization.
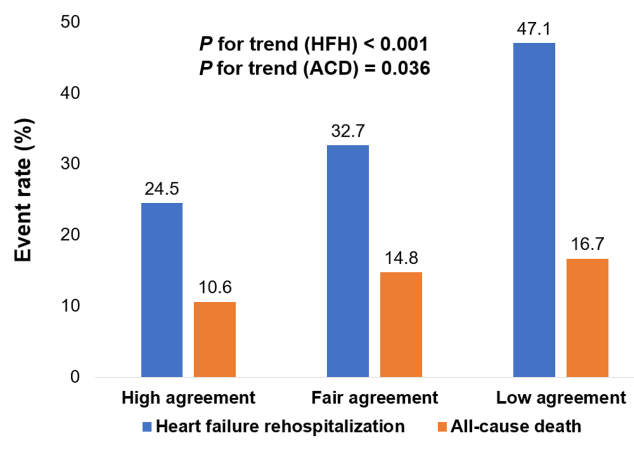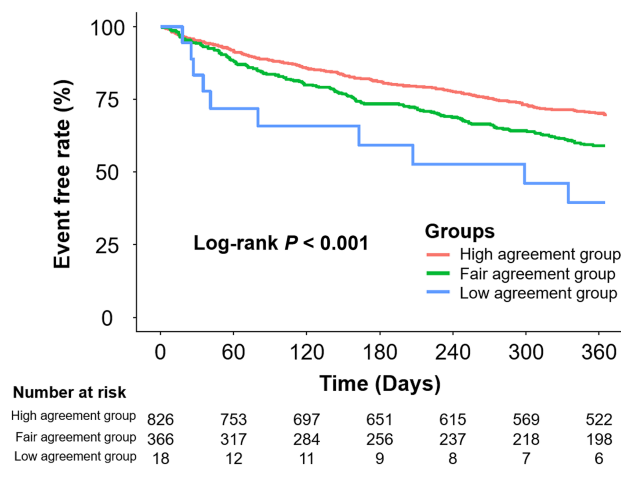


**Figure 2** Kaplan–Meier curves for all-cause death or heart failure rehospitalization according to level of agreement. Patients were divided into three groups based on the agreement score for reported comorbidities. Patients with lower agreement scores had worse prognoses ($P < 0.001$).



ment levels had a higher incidence of primary outcomes independent of other covariates, including the number of comorbidities.

This is the first study to report that the agreement between self-reported and provider-reported comorbidities among older hospitalized patients with heart failure is generally poor. Though a direct comparison was not performed, the agreements of hypertension, diabetes mellitus, COPD, and coronary artery disease were numerically lower in patients with heart failure compared with the general elderly population,[1–3] patients with cancer,[10–12] and patients with chronic kidney disease,[13,14] which may be due to a variety of reasons. As the FRAGILE-HF study focused on older patients with heart failure, the patient population in this study included older patients, and age is a strong predictor of disagreement between patient reports and medical records regarding the presence or absence of comorbidities.[9,11,12,28] However, the cohorts evaluated in some previous studies were the same age or older than the patients included in this study.[1–3] Therefore, heart failure itself might have contributed to the poor agreement observed in this study. The presence of cognitive dysfunction, which is strongly associated with heart failure, might have also contributed to the higher levels of disagreement in our study. A previous meta-analysis reported that patients with heart failure had a 1.67 times higher risk of cognitive impairment than patients without heart failure.[29] Cognitive dysfunction is likely to be associated with disagreement due to memory disorders or a lack of recognition. While 38% of the patients in this study had cognitive dysfunction, previous studies have either included very few patients with cognitive dysfunction,[2] excluded patients with cognitive dysfunction,[3] or did not report the presence or absence of cognitive dysfunction.[1,8–14,28] The number of

**Table 3** Cox hazards proportional analysis for all-cause mortality or heart failure rehospitalization

|  | Unadjusted | | | Model 1[a] | | | Model 2[b] | | |
|---|---|---|---|---|---|---|---|---|---|
|  | HR | 95% CI | *P*-value | HR | 95% CI | *P*-value | HR | 95% CI | *P*-value |
| High agreement group | 1 (reference) | | | 1 (reference) | | | 1 (reference) | | |
| Fair agreement group | 1.43 | 1.17–1.76 | <0.001 | 1.28 | 1.03–1.58 | 0.026 | 1.25 | 1.01–1.56 | 0.041 |
| Low agreement group | 2.60 | 1.38–4.89 | 0.003 | 2.81 | 1.44–5.48 | 0.002 | 2.74 | 1.40–5.35 | 0.003 |

CI, confidence interval; HR, hazard ratio.
[a]Model 1: adjusted for age, sex, body mass index, New York Heart Association class III or IV, current smoking status, systolic blood pressure, history of heart failure, hypertension, diabetes, atrial fibrillation, coronary artery disease, chronic obstructive pulmonary disease, estimated glomerular filtration rate, haemoglobin, albumin, sodium, left ventricular ejection fraction, angiotensin-converting enzyme inhibitor or angiotensin receptor blocker prescription, beta-blocker prescription, mineralocorticoid receptor antagonist prescription, and log-transformed brain natriuretic peptide.
[b]Model 2: adjusted for the variables listed in Model 1, cognitive dysfunction, and the number of comorbidities.

comorbidities may also be associated with disagreement. Patients with heart failure often have a high number of comorbidities. A clinical study on 122 630 patients with chronic heart failure reported that 39% had at least five comorbidities and 4% had no comorbidities.[30] An association between the number of comorbidities patients incorrectly recognize and the total number of comorbidities has been previously reported,[1,2,28] which is consistent with the results of this study.

In this study, the agreement levels varied widely among the different comorbidities. One possible explanation for these results might be the clarity in the definition of the diseases. Although diabetes mellitus is explicitly defined based on the blood test results, the diagnosis of hypertension, COPD, and coronary artery disease is less than clear-cut. Blood pressure varies depending on the time or place (i.e. home or hospital), and there is insufficient awareness regarding hypertension.[31] Similarly, the awareness rate of COPD is reportedly extremely low.[32] Regarding stroke and cancer, stroke often has a sudden onset and causes severe and lasting disability, and both are the life-threatening diseases; therefore, these diagnoses have a significant impact on the patient in most cases. Further, the moderate agreement levels might be attributed to the increased awareness regarding these two diseases. Clinicians, nurses, and caregivers should make patients aware of their comorbidities, especially hypertension and COPD.

This is the first study to report a significant association between the accuracy of patient-reported comorbidities and patient prognosis in any patient population. The mechanism of this relationship is unclear; however, poor recognition of comorbidities may be associated with poor medication adherence. A retrospective study on 31 636 patients revealed poorer medication adherence in patients with more comorbidities.[33] Healthcare providers should explain patients' current medical conditions, including comorbidities, more adequately, especially to older patients with a history of heart failure, cognitive dysfunction, and a high number of comorbidities. As these patients are at high risk for the inaccurate recognition of their comorbidities, the patient's family or proxies should also be involved in patient educa-tion. Moreover, pharmacist care and nurse practitioner education have been reported to improve knowledge of heart failure and clinical outcomes in patients with heart failure.[34,35] The association between the accuracy of patient-reported comorbidities and patient prognosis may also be a result of the association between the number of comorbidities and prognosis. In this study, the results were consistent even after adjusting for several confounders. However, further studies are needed to fully determine the effects of these confounders.

In previous studies, the clinical effects of educational intervention on patients with heart failure have been examined. Due to the reportedly poor knowledge of medications among elderly patients,[36,37] there may be room for intervention. One randomized controlled trial involving 223 patients with heart failure showed that educating patients regarding the cause of heart failure and rationale for heart failure medication by nurses reduced the incidences of death or rehospitalization.[38] In another randomized controlled trial on 200 hospitalized patients with heart failure, comprehensive care including education on diet, medication, and self-monitoring was associated with lower risk of heart failure rehospitalization.[39] However, this comprehensive care did not include education regarding the recognition of patients' comorbidities. Based on the results of our study, we believe that education on patients' comorbidities should be provided for patients with heart failure. However, as our opinion is not supported by substantial evidence, further studies are required to investigate the clinical efficacy of comprehensive care including education on patient's comorbidities.

This study is not without limitations. First, although several studies have reported that educational level is associated with the accordance or discordance of comorbidities between patient reports and medical records,[9,12,28] data regarding the patients' educational levels were not available. Previous studies have shown that educational level is not associated with the accuracy of the recognition of comorbidities[11,13]; however, this factor cannot be ruled out in this study. Second, the physician report was used as the gold standard in this study, though physicians may also misunderstand patients' comorbidities. Third, even though

healthcare utilization has shown to improve the outcomes in patients with heart failure,[40] we were unable to procure any data on healthcare utilization. Fourth, although we used the Mini-Cog test to evaluate cognitive dysfunction, its generalizability has been limited in patients with heart failure. Moreover, although we tried to evaluate cognitive dysfunction before discharge, hospitalized patients with acute heart failure may have temporary impaired cognitive function due to delirium or acute metabolic changes associated with heart failure, which might have impacted our study results. Fifth, objective assessment of the level of self-care in this study, such as the European Heart Failure Self-care Behavior Scale, was not evaluated. Moreover, whether the patients managed their medication by themselves or received help by their family/caregivers was not evaluated. Finally, this study included only Japanese patients; the generalizability of our findings may be limited.

In conclusion, patient-reported comorbidities were not accurate, and the poor recognition of comorbidities was associated with a poor prognosis in patients with heart failure.

## Conflict of interest

Dr. Yuya Matsue and Takatoshi Kasai are affiliated with a department endowed by Philips Respironics, ResMed, Teijin Home Healthcare, and Fukuda Denshi, and Dr. Yuya Matsue received honorariums from Otsuka Pharmaceutical Co. and Novartis Japan. Dr. Kagiyama reports grants from Philips, Asahi KASEI Corporation, Toho Holdings Co. Ltd, and Inter Reha Co. Ltd outside of the submitted work. Dr. Kamiya has received research funding from Eiken Chemical Co. Ltd. The remaining authors have nothing to declare.

## Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

**Figure S1.** Kaplan–Meier curves for all-cause death or heart failure rehospitalization according to level of agreement Patients were divided into four groups based on the level of agreement, as follows: complete agreement (agreement score of 6), more under-reporting, more over-reporting, or an equal number of under- and over-reporting. The complete agreement group had a longer event-free survival than the groups with disagreement.
**Table S1.** Logistic regression analysis for agreement.
**Table S2.** Cox hazards proportional analysis for all-cause death or heart failure re-hospitalization according to level of agreement.

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