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Impact of the clinical frailty scale on mid-term mortality in patients with ST-elevated myocardial infarction

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ABSTRACT

Background: "Frailty" is associated with poor prognosis in ST-elevated myocardial infarction (STEMI). However, there is little data regarding the impact of the Canadian Study of Health and Aging Clinical Frailty Scale (CFS), a simple and semiquantitative tool for assessing frailty, on mid-term mortality in STEMI patients.
Methods: A total of 354 consecutive STEMI patients (mean age 69.8 ± 12.4 years; male 76.6%) who underwent percutaneous intervention between July 2014 and March 2017 were retrospectively reviewed. The study endpoint was mid-term mortality according to the CFS classification. Furthermore, in order to clarify the impact of CFS upon admission on mid-term mortality, the independent predictors of all-cause death were evaluated.
Results: Patients were categorized into three groups (CFS 1–3, n = 281; CFS 4–5, n = 62; and CFS 6–7, n = 11). During the study period (median 474 days), all-cause death was observed in 39 patients. After multivariate Cox regression analysis, higher CFS (adjusted hazard ratio [HR] 2.34, 95% confidence interval [CI] 1.43–3.85, $p < 0.001$), higher Killip score (adjusted HR 2.46, 95%CI 1.30–5.78, $p = 0.002$), and lower serum albumin level (adjusted HR 4.29, 95%CI 2.16–8.51, $p < 0.001$) were significantly associated with an increased risk of all-cause death.
Conclusion: In conclusion, severe frailty was associated with mid-term mortality in STEMI patients who underwent PCI.

1. Introduction

The popularity of percutaneous coronary intervention (PCI) for the treatment of ST-elevation myocardial infarction (STEMI) has increased over the past decades. Currently, the concept of "frailty" has become more common in the field of intervention in which there is an increased tendency for dependency and/or mortality when a patient is exposed to a stressor. Frailty can occur as a result of a range of diseases and medical conditions [1]. Frailty is associated with body mass index (BMI) and serum albumin level, which are reported to correlate with a poor prognosis in patients with acute coronary syndrome (ACS) [2–4]. There are several frailty scoring systems. The Canadian Study of Health and Aging Clinical Frailty Scale (CFS) [5] is based on the clinician's judgement derived from an interview without the need for laboratory assessments or diagnostic testing devices. The scores are based on fitness, active disease, activities of daily living, and cognition. However, the impact of CFS, which is a simple tool for assessing patient frailty, on outcomes after STEMI is unclear. The aim of this study was to evaluate the impact of CFS on mid-term mortality in STEMI patients.

2. Methods

2.1. Study design and population

The medical records of 354 consecutive patients who were admitted to the Ogaki Municipal Hospital with acute STEMI and underwent primary PCI between July 2014 and March 2017 were retrospectively reviewed. The medical ethics committee of our hospital approved this study.

STEMI was defined as follows: (a) clinical evidence of ischemia (chest pain, chest tightness, radiating pain, dyspnea, nausea, and cold sweat); (b) electrocardiogram showing new ST elevation at the J-point in two contiguous leads, with a cutoff point of ≥0.2 mV in men and ≥0.15 mV in women in leads V2–V3 or ≥0.1 mV in the other leads; and (c) at least one high myocardial biomarker level, defined as serum troponin I or creatine kinase level above the 99th percentile of the normal reference population during the first 24 h after admission [6]. Patients were excluded if they had: (a) suspected STEMI but did not undergo coronary angiography (CAG) because of the attending physician's decision or

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patient's request; (b) coronary spasms or Takotsubo cardiomyopathy; or (c) culprit lesions but did not undergo PCI because of the attending physician's decision.

2.2. Data collection

Baseline patient characteristics, including age, sex, BMI, systolic and diastolic blood pressure, and heart rate were recorded. Hypertension was defined as current or previous treatment with antihypertensive medication. Diabetes mellitus was defined as current or previous treatment with antidiabetic medication (insulin or oral hypoglycemic drugs) or a hemoglobin A1c level of ≥6.5% (National glycohemoglobin standardization program) [7]. Dyslipidemia was defined as current or previous treatment with anti-dyslipidemic medication. Chronic kidney disease (CKD) was defined as an estimated glomerular filtration rate of <60 mL/min/1.73 m^2 [8]. Previous myocardial infarction, congestive heart failure, ischemic stroke, PCI, and coronary artery bypass grafting were recorded based on interviews with the patients and/or their relatives at admission. The time periods from the onset of myocardial infarction to reperfusion and from door to balloon were recorded. The laboratory findings recorded included the baseline white blood cell count, hemoglobin concentration, peak creatine kinase, peak creatine kinase MB isoenzyme, total cholesterol, triglycerides, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol (LDL-C), and albumin. The Killip classification was determined based on the physical examination findings and the systolic blood pressure. Significant cognitive disorder was defined as a score ≥ III for degree of independent living [9]. Frailty was assessed using the CFS [5,10]. Patients were categorized into three groups based on the CFS validation study [2,10,11]: CFS 1–3 (not frail), CFS 4–5 (at risk-to-mildly frail), and CFS 6–9 (frail). CFS data assessment was retrospectively performed by two investigators. CFS assessment was conducted with the primary physician using chart reviews which were prepared during very early cardiac rehabilitation by rehabilitation therapists as well as those made by nurses to assess patients' preadmission history, including activities of daily living and cognitive function, by interview to patients and their relatives.

2.3. Study endpoints

The study endpoint was mid-term mortality according to the CFS classification. Furthermore, in order to clarify the impact of CFS at admission on mid-term mortality, the independent predictors of mortality were evaluated.

2.4. Treatment protocol

Upon admission, the patients underwent a quick evaluation that included history taking and physical examination, electrocardiography, chest radiography, echocardiography, and blood tests. In this study, the patients underwent immediate coronary angiography and primary PCI. Written informed consent was obtained from each patient and/or the patient's relatives before PCI. None of the patients received systemic thrombolytic therapy. Other therapeutic interventions were performed at the discretion of the attending physician, including blood transfusion for anemia, mechanical ventilation for respiratory failure or shock, administration of diuretics for congestive heart failure, and administration of inotropes for hypotension or hypoperfusion.

2.5. Statistical analysis

Continuous variables are expressed as means ± standard deviations (SD) or median and interquartile range (IQR; 25%–75%). Comparisons of clinical, angiographic, or procedure-related characteristics were performed using the chi-square test for categorical covariates, the 1-way analysis of variance for continuous covariates that were listed as mean value and SD and the Kruskal-Wallis test for continuous variables that were listed as medians with interquartile range according to the CFS.

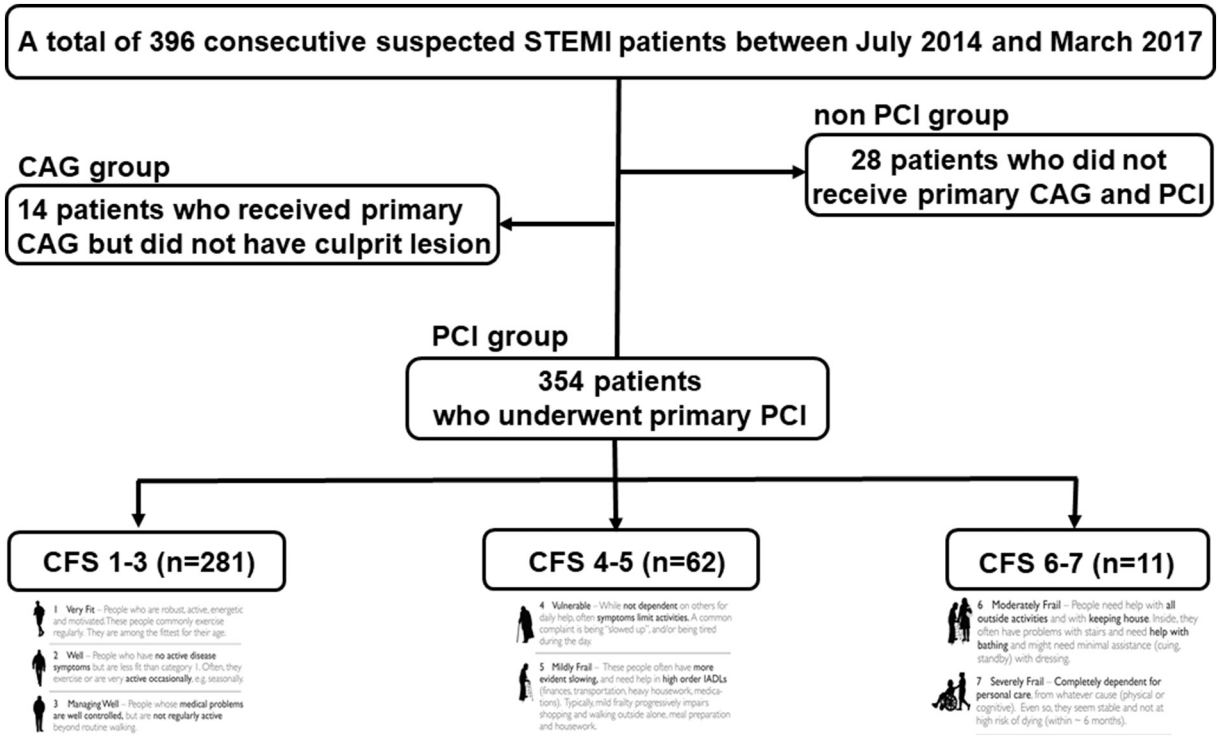

Fig. 1. Study population and classification.

Comparisons of event-free survival (Kaplan–Meier curves) were performed with the log-rank test. A Cox regression analysis, using selected covariates, was performed to determine the independent predictors of mid-term all-cause death during the follow-up period following STEMI-PCI. The selected variables were, CFS, age ≥ 75, BMI, CKD, Killip class ≥ III, serum hemoglobin level, and serum albumin level < 3.5 g/dL, based on their association with mid-term all-cause death ($p < 0.1$). Other variables were identified in a previously published study [12] (sex, dyslipidemia, diabetes mellitus, hypertension, and current smoking). To avoid over-fitting, the number of variables used in the final multivariable model was limited to 1 for every 8 to 10 events. The results are reported as adjusted hazard ratios (a-HR) with associated 95% confidence intervals (CIs). We used SPSS version 22 (SPSS Inc., Chicago, Illinois) for all statistical analyses. All p-values were two-tailed, and results with $p < 0.05$ were considered to be statistically significant for all analyses.

Table 1
Baseline patient characteristics, procedural characteristics and clinical outcome.

	Overall n = 354	CFS 1–3 n = 281	CFS 4–5 n = 62	CFS 6–7 n = 11	p value
-Patient clinical characteristics					
Age, years	69.8 ± 12.4	66.2 ± 11.1	83.5 ± 4.6	84.4 ± 8.0	<0.001
Age ≥ 75 years, n (%)	131 (37.0)	62 (22.1)	59 (95.2)	10 (90.9)	<0.001
male, n (%)	271 (76.6)	239 (85.1)	26 (41.9)	6 (54.5)	<0.001
Body mass index, kg/m^2	23.7 ± 4.5	23.9 ± 3.8	23.0 ± 6.8	23.8 ± 5.6	0.40
Prior heart failure, n (%)	6 (1.7)	3 (1.1)	2 (3.2)	1 (9.1)	0.076
Prior MI, n (%)	30 (8.5)	21 (7.5)	6 (9.7)	3 (27.3)	0.064
Prior PCI, n (%)	32 (9.0)	22 (7.8)	9 (14.5)	1 (9.1)	0.25
Prior CABG, n (%)	2 (0.6)	2 (0.7)	0 (0)	0 (0)	0.77
Prior ischemic stroke, n (%)	14 (4.0)	8 (2.8)	5 (8.1)	1 (9.1)	0.10
Dyslipidemia, n (%)	231 (65.3)	191 (68)	35 (56.5)	5 (45.5)	0.065
Diabetes mellitus, n (%)	96 (27.1)	75 (26.7)	19 (30.6)	2 (18.2)	0.65
Hypertension, n (%)	190 (53.7)	150 (53.4)	36 (58.1)	4 (36.4)	0.40
current smoking, n (%)	141 (39.8)	118 (42.0)	20 (32.3)	3 (27.3)	0.23
CKD, n (%)	156 (44.1)	104 (37.0)	45 (72.6)	7 (63.6)	<0.001
-Findings at presentation					
Systolic blood pressure, mm Hg	132.0 ± 32.5	133.0 ± 33.3	127.6 ± 30.3	131.7 ± 24.5	0.50
Diastolic blood pressure, mm Hg	77.9 ± 21.9	79.8 ± 22.7	70.0 ± 16.8	74.5 ± 16.0	0.006
Heart rate, bpm	75.4 ± 23.4	75.2 ± 23.6	74.6 ± 20.0	86.2 ± 23.6	0.28
Killip class	1.4 ± 0.8	1.3 ± 0.8	1.4 ± 0.8	1.8 ± 1.0	0.11
Killip class ≥ 3, n (%)	32 (9.0)	23 (8.2)	7 (11.3)	2 (18.2)	0.42
Hemoglobin, g/dL	13.6 ± 2.0	14.0 ± 1.8	11.9 ± 1.8	12.5 ± 2.7	<0.001
LDL-cholesterol, mg/dL	116.5 ± 36.7	121.0 ± 95.6	99.4 ± 28.1	99.7 ± 33.2	<0.001
HDL-cholesterol, mg/dL	43.5 ± 12.4	43.4 ± 11.4	43.0 ± 13.0	47.9 ± 26.7	0.47
Total-cholesterol, mg/dL	184.6 ± 43.1	189.4 ± 44.2	165.4 ± 33.0	170.7 ± 33.3	<0.001
Triglycerides, mg/dL	114.5 ± 89.8	121.0 ± 95.6	95.2 ± 59.8	60.9 ± 27.3	0.016
eGFR, mL/min/1.73 m^2	63.4 ± 23.7	66.8 ± 22.5	50.2 ± 23.9	58.7 ± 26.4	<0.001
Albumin, g/dL	4.1 ± 0.5	4.2 ± 0.5	3.7 ± 0.5	3.8 ± 0.5	<0.001
Albumin < 3.5 g/dL, n (%)	35 (9.9)	18 (6.4)	15 (24.2)	2 (18.2)	<0.001
White blood cell count, ×10^3/μL	10.1 ± 3.6	10.2 ± 3.6	9.5 ± 3.4	10.8 ± 4.4	0.29
peak CK, IU/L	1823.5 (782.8–3216.0)	1834.0 (798.0–3349.5)	1457.0 (689.8–2922.3)	1917.0 (426.0–5138.0)	0.34
peak CKMB, IU/L	180.5 (80.8–310.8)	181.0 (81.0–304.0)	169.0 (72.5–313.5)	222.0 (40.0–484.0)	0.85
-Lesion characteristics					
LMT, n (%)	8 (2.3)	7 (2.5)	1 (1.6)	0 (0)	0.80
LAD, n (%)	179 (50.6)	151 (53.7)	20 (32.3)	8 (72.7)	0.003
LCx, n (%)	26 (7.3)	19 (6.8)	7 (11.3)	0 (0)	0.30
RCA, n (%)	140 (39.5)	104 (37.0)	34 (54.8)	2 (18.2)	0.01
RCA & LCx, n (%)	1 (0.3)	0 (0)	0 (0)	1 (9.1)	<0.001
-Time to reperfusion					
Onset to reperfusion time, hour	3.6 (2.3–7.0)	3.5 (2.2–6.4)	4.5 (2.6–9.6)	5.7 (3.0–15.2)	0.052
Door to balloon time, minutes	79.0 (61.0–111.0)	76.0 (60.0–110.8)	85.5 (67.3–110.3)	120.0 (82.0–163.0)	0.078
-Contrast and fluoroscopy					
Contrast volume, mL	135.2 ± 54.2	139.8 ± 52.7	115.6 ± 51.6	127.5 ± 81.2	0.006
Fluoroscopy time, minutes	22.8 (15.6–31.4)	22.9 (15.3–31.8)	22.7 (17.7–29.8)	27.0 (14.2–35.9)	0.93
Exposure dose, mGy	1342.0 (915.0–1937.0)	1375.0 (971.0–2014.0)	1041.0 (680.8–1668.5)	1278.0 (1050.0–1917.0)	0.014
-In hospital clinical outcome					
All death, n (%)	20 (5.6)	14 (5.0)	4 (6.5)	2 (18.2)	0.17
Cardiac death, n (%)	18 (5.1)	12 (4.3)	4 (6.5)	2 (18.2)	0.10
CABG, n (%)	0 (0)	0 (0)	0 (0)	0 (0)	–
Stent thrombosis, n (%)	0 (0)	0 (0)	0 (0)	0 (0)	–
-Clinical outcome					
All death, n (%)	39 (11.0)	21 (7.5)	13 (21.0)	5 (45.5)	<0.001
Cardiac death, n (%)	26 (7.3)	17 (6.0)	6 (9.7)	3 (27.3)	0.022
Non cardiac death, n (%)	13 (3.7)	4 (1.4)	7 (11.3)	2 (18.3)	<0.001
CABG, n (%)	0 (0)	0 (0)	0 (0)	0 (0)	–
Stent thrombosis, n (%)	0 (0)	0 (0)	0 (0)	0 (0)	–

Values are numbers (%) or mean ± SD. CFS, clinical frailty scale; MI, myocardial infarction; PCI, percutaneous coronary intervention; CABG, coronary artery bypass grafting; CKD, chronic kidney disease; LDL, Low-density lipoprotein; HDL, High-density lipoprotein; eGFR, estimated glomerular filtration rate CK, creatine kinase; CKMB, creatine kinase MB; LMT, left main trunk; LAD, left anterior descending artery; LCx, left circumflex artery; RCA, right coronary artery.

3. Results

During the study period, 354 consecutive patients with STEMI were treated with PCI in our institute.

Patients (with no age limit, the youngest patient was 27 years and the oldest patient was 96 years) were further subdivided based on CFS classification: 281 patients (79.4%) in CFS 1–3, 62 patients (17.5%) in CFS 4–5, and 11 patients (3.1%) in CFS 6–7. There was no patient with CFS ≥ 8 (Fig. 1). The median clinical follow-up was 474 days (first to third quartile: 323–737 days).

Baseline clinical, laboratory, and procedural characteristics by CFS are shown in Table 1. This cohort had a mean age of 69.8 ± 12.4 years, and 76.6% were male. One hundred and ninety patients (53.7%) had hypertension, 96 (27.1%) had diabetes mellitus, and 231 (65.3%) had dyslipidemia. The median time from onset to reperfusion was 3.6 h (first to third quartile: 2.3–7.0 h), and the median time from door to balloon was 79.0 min (first to third quartile: 61.0–111.0 min). Thirty-two patients (9.0%) were classified as Killip class III or IV. Among the three study groups, significant differences were observed in mean age, gender, CKD, diastolic blood pressure, hemoglobin, total cholesterol, LDL-C, triglycerides, and serum albumin level.

During the follow-up period, 39 patients died after PCI. The mortality of patients increased as CFS increased. All-cause death occurred in each group as follows: CFS 1–3, 21 of 281 (7.5%); CFS 4–5, 13 of 62 (21.0%); and CFS 6–7, 5 of 11 (45.5%) patients ($p < 0.001$). The causes of death according to the CFS classification were as follows: CFS 1–3 comprised 17 cardiac deaths, 2 malignancies, 1 due to pneumonia, and 1 due to asthenia; CFS 4–5 included 6 cardiac deaths, 2 malignancies, 1 due to pneumonia, 1 due to asthenia, 1 cerebral contusion, and 2 due to unknown causes; and CFS 6–7 included 3 cardiac deaths, and 2 due to asthenia.

The Kaplan-Meier analysis of cumulative mortality in the three groups on the basis of CFS is presented in Fig. 2. The baseline clinical characteristics of all 354 patients and the results of the univariate regression analyses for mid-term all-cause deaths are shown in Table 2. Severe CFS, older age, higher Killip score, lower BMI, lower systolic and diastolic blood pressure, higher heart rate, lower hemoglobin, lower serum albumin, LDL-C, total cholesterol, and triglycerides levels and renal failure were significantly associated with an increased risk of mid-term all-cause mortality on univariate analysis. Furthermore, Cox multivariate regression analysis identified higher CFS (a-HR 2.46, 95% CI 1.52–3.98, $p < 0.001$); higher Killip score (a-HR 3.10, 95% CI 1.50–6.39, $p = 0.002$); and lower serum albumin level (a-HR 4.29, 95% CI 2.16–8.51, $p < 0.001$) as independent predictors of mid-term all-cause mortality (Table 2). CFS was a significant predictor of mid-term all-cause death. In patients with CFS 1–3 and CFS 4–5, both serum albumin level and Killip score had a significant impact on mortality but did not have an impact in patients with CFS 6–7 (Fig. 3). As shown in Fig. 4, the distribution rates of CFS differed across age groups. In younger subjects, there were few patients who were categorized as having severe CFS. Furthermore, the severity of CFS increased with age.

Furthermore, we examined the patients in whom the CFS classification altered during admission. There were 11 patients who had an altered CFS classification. Of these 11 patients, 4 patients had died during the follow-up period (Table 3).

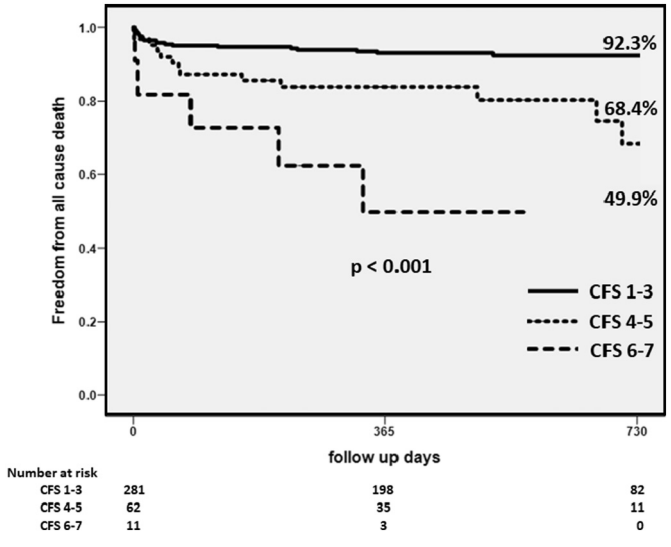

Fig. 2. Kaplan-Meier analysis of cumulative mortality in the three groups with respect to CFS. CFS – clinical frailty scale.

4. Discussion

CFS is a simple and effective semiquantitative marker for a baseline objective and non-invasive assessment of patients' characteristics. In this study, we evaluated consecutive patients with STEMI regardless of age with a mid-term follow-up period. To the best of our knowledge, this is the first study to show that CFS was independently associated with a poor prognosis in patients of all ages who underwent PCI for STEMI. Geriatric patients have been investigated in most frailty studies, and frailty has been associated with mortality in these patients [10,13]. For ACS, Matsuzawa et al. reported that slow gait speed (as a marker of frailty) was significantly associated with an increased risk of cardiovascular events in 472 patients with STEMI [14]. Furthermore, White et al. showed the correlation between frailty and worse outcomes in 9326 patients with ACS [15] and Alegre et al. reported that another frailty assessment tool, the FRAIL scale, was a significant predictor of mortality in ACS patients [16]. Corresponding with previous reports, our study indicated that CFS is independently associated with poor mid-term outcomes in patients with STEMI.

CFS was developed using data from the Canadian of Health and Aging on elderly Canadians aged 65 years or older. Our study population was relatively younger than those of previous studies and included Japanese patients <65 years old. This study also showed that CFS can be applicable for non-elderly and Asian patients.

Notably, this study demonstrated that a frailty-associated parameter, serum albumin level (<3.5 g/dL), was also associated with an increased risk of mid-term all-cause mortality according to multivariate analysis, thereby emphasizing the impact of frailty. Generally, albuminemia, which is an indicator of malnutrition, has been considered an important parameter of frailty and is associated with a poor prognosis in cardiac disease patients [17]. In addition, BMI is also associated with an increased risk of mid-term mortality in univariate analysis and is reported to be related to poor clinical outcomes in patients with STEMI [18]. Although obesity is associated with cardiovascular risk factors, such as hypertension, diabetes mellitus, and dyslipidemia [19], this study showed that a markedly lower BMI was related to a poor outcome following PCI in patients with STEMI due to cardiac cachexia, malnutrition, or depression [20]. A low serum albumin level and low BMI are identified as markers of frailty [21], and these findings underpin the important role of "frailty" in mid-term mortality. Considering the poor outcome in patients with severe frailty who were treated with PCI for STEMI, the indication for intervention in those patients should be carefully determined. Indeed, Ekerstad et al. demonstrated that CFS was strongly and independently associated with in-hospital all-cause mortality and 1-month mortality in 307 patients with non-STEMI, and angiography was not performed in most of the frail patients (CFS ≥ 6) [22]. In STEMI patients with severe frailty, it may be possible to consider a rework of therapeutic strategy, including whether to perform PCI.

Generally, a higher Killip score, lower systolic blood pressure, higher heart rate, older age, and higher serum creatinine level are associated with high mortality in ACS patients [23]. Indeed, our data showed that a higher Killip score, lower systolic and diastolic blood pressure, and higher heart rate were significantly associated with mid-term all-cause death on univariate analysis. Of these, only the Killip score retained a

Table 2
Univariate and Multivariate regression analysis for the association between mid-term all-cause mortality and clinical findings.

Factors for predicting	Univariate analysis			Multivariate analysis		
	Mid-term all-cause mortality					
	HR	95% CI	p value	HR	95% CI	p value
-Patient clinical characteristics						
CFS (1–3, 4–5, 6–7)	2.98	1.91–4.65	<0.001	2.46	1.52–3.98	<0.001
Age (per 1 year increase)	1.07	0.81–0.98	<0.001			
Age ≧ 75	3.42	1.77–6.59	<0.001			
Gender (male)	0.68	0.34–1.34	0.26			
Body mass index, kg/m^2	0.89	0.81–0.98	0.012			
Prior heart failure	1.49	0.20–10.83	0.70			
Prior MI	1.66	0.65–4.23	0.29			
Prior PCI	1.17	0.42–3.30	0.76			
Prior CABG	0.05	0.001–1.11 × 10^7	0.76			
Prior ischemic stroke	0.64	0.09–4.65	0.66			
Dyslipidemia	0.63	0.33–1.20	0.16			
Diabetes mellitus	0.68	0.31–1.47	0.33			
Hypertension	0.74	0.40–1.39	0.35			
Current smoking	0.88	0.46–1.68	0.70			
CKD	4.67	2.21–9.88	<0.001			
-Findings at presentation						
Systolic blood pressure, mm Hg	0.98	0.97–0.99	<0.001			
Diastolic blood pressure, mm Hg	0.97	0.96–0.99	<0.001			
Heart rate, bpm	1.02	1.01–1.03	0.002			
Killip class	2.23	1.76–2.84	<0.001			
Killip class ≥ 3	5.66	2.87–11.2	<0.001	3.10	1.50–6.39	0.002
Hemoglobin, g/dL	0.74	0.64–0.84	<0.001			
LDL-cholesterol, mg/dL	0.99	0.98–1.00	0.004			
HDL-cholesterol, mg/dL	0.97	0.94–1.00	0.059			
Total-cholesterol, mg/dL	0.98	0.98–0.99	0.001			
Triglycerides, mg/dL	0.99	0.99–1.00	0.013			
eGFR, mL/min/1.73 m^2	0.97	0.96–0.98	<0.001			
Albumin, g/dL	0.14	0.09–0.22	<0.001			
Albumin <3.5 g/dL, n(%)	7.46	3.93–14.13	<0.001	4.29	2.16–8.51	<0.001
White blood cell count, ×10^3/μL	1.00	1.00–1.00	0.060			

HR, hazard ratio; CI, confidence interval; other abbreviations as in Table 1.

significant correlation with both mortality indexes on multivariate analysis. However, it is important that the CFS and low albuminemia, but not comorbidities, such as diabetes mellitus and CKD, and older age, could predict mid-term mortality in the consecutive patients with STEMI, as CFS is useful for assessing prognosis in other clinical conditions [11,24].

CFS is a useful and simple predictor of mid-term mortality in patients who undergo PCI for STEMI. Frailty can be conceptualized as a phenotype of weight loss, fatigue, and weakness or a multidimensional state of vulnerability arising from a complex interplay of biological, cognitive, and social factors. Our report showed that severe frailty was a significant predictor of both cardiac and non-cardiac death. Our findings suggest that frailty is strongly relevant to mortality in STEMI patients due to multifactorial variables. In other words, it is possible to improve the outcome in frail patients with STEMI by interventions targeted at these factors. Therefore, early intervention in synergy with social work, home care, and cardiac rehabilitation, in addition to functional independence, social support, medication compliance, and nutrition

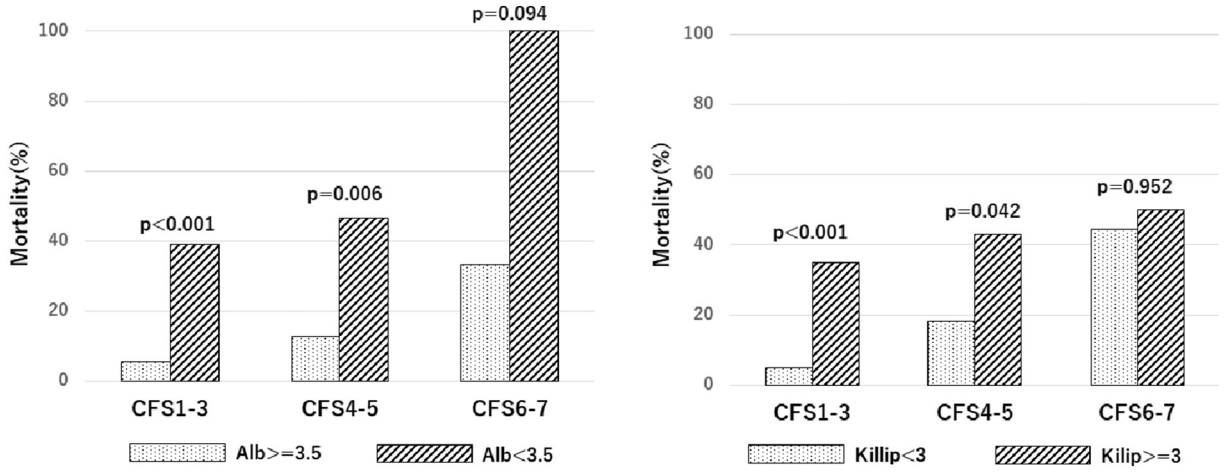

Fig. 3. The distribution of mortality according to the CFS classification and serum albumin level and CFS and Killip classifications. CFS – clinical frailty scale.

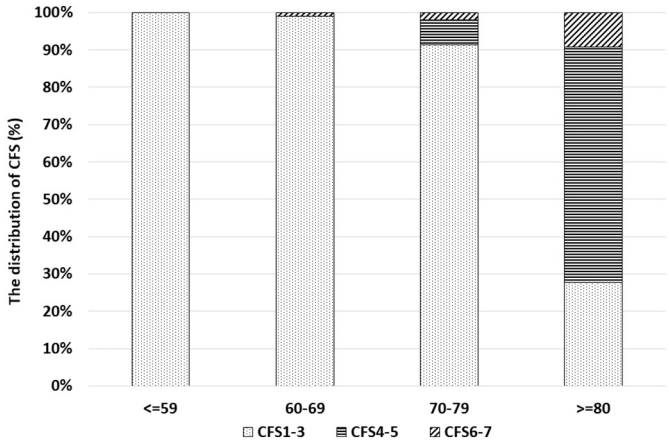

Fig. 4. Distribution of CFS scores by age. CFS – clinical frailty scale.

should be considered to improve mortality in these patients [25–27]. Moreover, considering that a relatively high mortality was recorded in patients whose CFS classification were worse following primary PCI, preventing the worsening of CFS could also be important during STEMI treatment in daily practice.

In recent decades, the in-hospital mortality of patients with STEMI has been low (2.6%) as reported by the CVIT 2018 annual report in 41,774 patients [28]. However, a higher age (68.5 years vs. 69.8 years) and more comorbidities (renal insufficiency; 12.8% vs. 37.0%) might increase the in-hospital mortality in our institute. On the other hand, in the MIYAGI-AMI Registry, which is located in the rural areas, Hao et al. reported that the in-hospital mortality of 8640 patients with acute myocardial infarction (AMI) between 2002 and 2010 was 6.4% [29]. Therefore, the covered area might be associated with an increased risk of in-hospital mortality due to prolonged onset to balloon time and insufficient information of coronary artery disease.

4.1. Limitations

This study had several limitations. First, it had a single-center retrospective design. Second, no patient was categorized as CFS 8 or 9, and a relatively small number of patients were categorized as CFS 4–5 and CFS 6–7. Therefore, care should be taken while interpreting the indication for these patients with STEMI. Third, the CFS classification was not evaluated at admission because of the retrospective design, and in cases in which the primary physician was not present, we estimated the CFS score based on chart review. Fourth, the synergistic effects of social work, home care, and cardiac rehabilitation were not evaluated in this study. Fifth, the possibility of CFS in improving the currently available risk prediction models (such as GRACE score, TIMI risk score) is unclear because of the limited number of patients in this study. Finally, as the patients with severe frailty usually had more comorbidities, it is difficult to interpret whether frailty itself had a direct impact on all-cause death. Further studies are necessary to provide new risk scores, such as CFS for in-hospital and mid-term mortality. Further investigations are needed to clarify the indications for PCI for frail patients with STEMI.

Table 3
Patients characteristics who changed CFS class during admission.

Patients	Age	Sex	Pre CFS	Post CFS	Killip class	Intensive care	Mid-term all-cause death	Cause of death
1	66	M	1	7	1	Yes	Yes	Asthenia
2	72	M	1	7	1	Yes	Yes	Cardiac
3	83	F	4	7	1	–	Yes	Malignancy
4	74	M	5	6	1	–	Yes	Malignancy
5	58	M	1	7	4	Yes	–	–
6	68	M	1	6	2	Yes	–	–
7	80	M	4	6	1	Yes	–	–
8	87	M	4	6	1	–	–	–
9	94	F	4	7	2	–	–	–
10	88	M	5	6	1	–	–	–
11	88	F	5	6	1	–	–	–

PCI, percutaneous coronary intervention; CFS, clinical frailty scale; M, male; F, female; Intensive care; any use of intra aortic balloon pumping, percutaneous cardio-pulmonary support, and tracheal intubation.

5. Conclusions

The simple parameters, CFS, hypoalbuminemia, and a higher Killip score were strongly associated with mid-term mortality in patients treated with PCI for STEMI.

Conflict of interest

The authors have no financial relationships to disclose and there are no conflicts of interest regarding the content of the manuscript.

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