Specialty-Related Differences in the Acute-Phase Treatment and Prognosis in Patients With Acute Heart Failure
— Insights From REALITY-AHF —

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Background: The aim of this study was to assess specialty-related differences in the treatment for patients with acute heart failure (AHF) in the acute phase and subsequent prognostic differences.

Methods and Results: We analyzed hospitalizations for AHF in REALITY-AHF, a multicenter prospective registry focused on very early presentation and treatment in patients with AHF. All patients were classified according to the medical specialty of the physicians responsible for contributing most to decisions regarding the initial diagnosis and treatment after the emergency department (ED) arrival. Patients initially managed by emergency physicians (n=614) or cardiologists (n=911) were analyzed. After propensity-score matching, vasodilators were used less often by emergency physicians than by cardiologists at 90 min after ED arrival (29.8% vs. 46.1%, P<0.001); this difference was also observed at 6, 24, and 48 h. Cardiologists administered furosemide earlier than emergency physicians (67 vs. 102 min, P<0.001). However, the use of inotropes, noninvasive ventilation, and endotracheal intubation were similar between groups. In-hospital mortality did not differ between patients managed by emergency physicians and those managed by cardiologists (4.1% vs. 3.8%, odds ratio 1.12; 95% confidence interval 0.58–2.14).

Conclusions: Despite differences in initial management, no prognostic difference was observed between emergency physicians and cardiologists who performed the initial management of patients with AHF.

Key Words: Acute heart failure; Emergency department; Medical specialty; Prognosis

Hospitalization of patients with acute heart failure (AHF) is a growing and major public health issue associated with high morbidity, mortality, and rehospitalization rates.1–4 Approximately 80% of patients with AHF treated in the emergency department (ED) are ultimately admitted to the hospital.3 Therefore, the ED serves as the principal portal of entry for hospitalized patients with AHF and functions as the initial point at which definitive healthcare contact and primary stabilization occur. Rapid and accurate diagnosis of AHF is vital, and delayed therapy leads to increased mortality,5,6 which suggests the importance of early management for AHF in the ED.

AHF is a syndrome in which emergency physicians, intensivists, cardiologists, internists, and hospitalists must cooperate to provide beneficial management that improves the patient’s clinical outcome. Despite the dissemination of clinical guidelines on the treatment of HF,1 there could be
specially-related variations in clinical practice patterns for patients with AHF because the management of AHF remains largely opinion-based with little plausible evidence. Additionally, previous reports have suggested that differences in the specialty-related process of care during the index hospitalization of patients with AHF are associated with differences in specialty-related outcomes. However, most of those reports focused on management after admission, and data on acute-phase management remain sparse. Therefore, the purpose of this study was to clarify the specialty-related differences in the treatment for patients with AHF in the acute phase and subsequent prognostic differences.

Methods

Study Design and Selection of Participants
We used data from the Registry Focused on Very Early Presentation and Treatment in Emergency Department of Acute Heart Failure Syndrome (REALITY-AHF), the design of which has been published previously. Briefly, the REALITY-AHF was a prospective, multicenter, observational registry designed to evaluate the prognostic effect of treatment of AHF in the acute phase. All patients with AHF hospitalized through the ED at participating hospitals were consecutively enrolled upon initial hospital admission. Patients were eligible for inclusion in the REALITY-AHF if they met the modified Framingham criteria and had been diagnosed with AHF within 3 h of the first evaluation by medical staffs in the ED. The exclusion criteria were: (1) age <20 years, (2) treatment with an intravenous (IV) drug prior to ED arrival, (3) previous cardiac transplantation, (4) treatment with either chronic peritoneal dialysis or hemodialysis, (5) acute myocarditis, and (6) acute coronary syndrome requiring emergency or urgent revascularization. Patients with missing data for B-type natriuretic peptide (BNP) or N-terminal-proBNP levels and patients with a BNP level <100 pg/mL or N-terminal-proBNP level <300 pg/mL at admission were also excluded. Eligibility was not contingent on the use of any particular therapeutic agent or treatment.

The participating institutes included 9 university hospitals and 11 non-university teaching hospitals. Study enrollment was performed from August 2014 to December 2015 with a follow-up of 1 year after discharge for each patient. The study protocol conformed to the Declaration of Helsinki and Japanese Ethical Guidelines for Medical and Health Research Involving Human Subjects. The study protocol was approved by the human (ethics) committee at each participating hospital; however, informed consent from individuals was not required for registry entry, and an opt-out method for participant recruitment was used because obtaining written informed consent in the ED may have delayed treatment and subsequently biased the results. Study information, which included the study objectives, inclusion and exclusion criteria, and names of participating institutes, was publicized in the University Hospital Information Network (UMIN-CTR, unique identifier: UMIN000014105) before enrollment of the first patient.

Data Collection, Definitions, and Outcomes
The data in REALITY-AHF include the patients’ demographic information, medical history, baseline clinical characteristics in the ED phase, treatment performed until 48 h after ED arrival, and clinical outcomes. The first 48 h after ED arrival were divided into 4 time windows: from ED arrival to 90 min after ED arrival, from 90 min to 6 h, from 6 to 24 h, and from 24 to 48 h. In each time window, treatment including noninvasive ventilation (NIV), endotracheal intubation (ETI), and IV drug administration were recorded. The frequency of ETI, intra-aortic balloon pumping, extracorporeal membrane oxygenation, and renal replacement therapy during hospitalization were also checked. In this registry, the time from the patient’s arrival in the ED to the first IV furosemide administration was recorded for all patients as the door-to-furosemide (D2F) time. Because a D2F <60 min is reportedly associated with a better in-hospital prognosis, the proportion of patients treated with furosemide within 60 min of arrival was also evaluated.

We classified all patients according to the medical specialty of the physician most responsible: emergency physician, cardiologist and other physicians. The physician most responsible was defined as the one who contributed most to decisions regarding the initial diagnosis and treatment in the ED. Physician specialties were assigned by each institute and reflected both the level of training of the physicians and the type of treatment provided by them.

The primary outcome of this study was all-cause inhospital death. The secondary outcomes were length of hospital stay, 1-year all-cause death, and specialty-related differences in medical treatment until 48 h after ED arrival and during hospitalization.

Statistical Analysis
Continuous variables are expressed as mean±standard deviation or median (interquartile range). Categorical data were compared using chi-square tests or Fisher’s exact tests. The treatment unit and the type of treatment provided by them.

The Guest Editor for this article was Dr. Yoshihiko Saito.
Table 1. AHF Patients’ Characteristics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Before match</th>
<th>After match</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), years</td>
<td>Emergency physicians (n=614)</td>
<td>Cardiologists (n=911)</td>
<td>0.99</td>
</tr>
<tr>
<td></td>
<td>77 (12)</td>
<td>77 (13)</td>
<td></td>
</tr>
<tr>
<td>Male sex, n (%)</td>
<td>346 (56.4)</td>
<td>504 (55.3)</td>
<td>0.69</td>
</tr>
<tr>
<td>Arrival by ambulance, n (%)</td>
<td>442 (72.0)</td>
<td>466 (51.2)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Systolic BP, mean (SD), mmHg</td>
<td>151 (39)</td>
<td>147 (35)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diastolic BP, mean (SD), mmHg</td>
<td>84 (27)</td>
<td>83 (24)</td>
<td>0.02</td>
</tr>
<tr>
<td>Heart rate, mean (SD), beats/min</td>
<td>101 (27)</td>
<td>96 (30)</td>
<td>0.27</td>
</tr>
<tr>
<td>Symptom onset time, n (%)</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>≤6h</td>
<td>195 (31.8)</td>
<td>172 (18.9)</td>
<td></td>
</tr>
<tr>
<td>6h–2 days</td>
<td>130 (21.2)</td>
<td>193 (21.2)</td>
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</tr>
<tr>
<td>&gt;2 days</td>
<td>288 (47.0)</td>
<td>545 (59.9)</td>
<td></td>
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<tr>
<td>ECG rhythm, n (%)</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Sinus</td>
<td>372 (60.6)</td>
<td>441 (48.7)</td>
<td></td>
</tr>
<tr>
<td>AF</td>
<td>180 (29.3)</td>
<td>366 (40.4)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>62 (10.1)</td>
<td>99 (10.9)</td>
<td></td>
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<tr>
<td>LVEF in ED, n (%)</td>
<td></td>
<td></td>
<td>0.54</td>
</tr>
<tr>
<td>&lt;35%</td>
<td>232 (39.1)</td>
<td>314 (37.3)</td>
<td></td>
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<tr>
<td>35–50%</td>
<td>176 (29.7)</td>
<td>242 (28.7)</td>
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<tr>
<td>&gt;50%</td>
<td>185 (31.2)</td>
<td>286 (34.0)</td>
<td></td>
</tr>
<tr>
<td>Medical history, n (%)</td>
<td>History of HF</td>
<td>300 (48.9)</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td>433 (70.5)</td>
<td>590 (64.9)</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>240 (39.1)</td>
<td>321 (35.3)</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>181 (29.5)</td>
<td>278 (30.6)</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>55 (9.0)</td>
<td>81 (8.9)</td>
<td>0.99</td>
</tr>
<tr>
<td>Physical findings in ED, n (%)</td>
<td>Peripheral edema</td>
<td>393 (64.1)</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>286 (47.1)</td>
<td>559 (62.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>364 (59.5)</td>
<td>519 (57.2)</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>441 (71.8)</td>
<td>665 (73.2)</td>
<td>0.57</td>
</tr>
<tr>
<td></td>
<td>405 (66.1)</td>
<td>608 (67.0)</td>
<td>0.72</td>
</tr>
<tr>
<td>Medications on admission, n (%)</td>
<td>Loop diuretics</td>
<td>279 (45.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>ACEIs</td>
<td>98 (16.0)</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>ARBs</td>
<td>168 (27.4)</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>αβ-blockers</td>
<td>245 (40.0)</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>Aldosterone blockers</td>
<td>125 (20.4)</td>
<td>0.20</td>
</tr>
<tr>
<td>Laboratory data</td>
<td>WBC, median (IQR), /μL</td>
<td>8,300 (6,200–11,200)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Hb, median (IQR), g/dL</td>
<td>11.8 (10.3–13.3)</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>AST, median (IQR), IU/L</td>
<td>32 (23–49)</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>ALT, median (IQR), IU/L</td>
<td>23 (14–39)</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>Creatinine, median (IQR), mg/dL</td>
<td>1.07 (0.85–1.52)</td>
<td>0.21</td>
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<tr>
<td></td>
<td>BUN, median (IQR), mg/dL</td>
<td>25 (18–34)</td>
<td>0.44</td>
</tr>
<tr>
<td></td>
<td>Glucose, median (IQR), mg/dL</td>
<td>151 (117–226)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Sodium, mean (SD), mEq/L</td>
<td>138 (5)</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>CRP, median (IQR), mg/dL</td>
<td>0.71 (0.21–2.06)</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>BNP, median (IQR), pg/mL</td>
<td>778 (482–1,394)</td>
<td>0.08</td>
</tr>
<tr>
<td>GW TG-HF risk score, mean (SD)</td>
<td></td>
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</table>

Data are presented as number (percentage) of patients, mean ± SD, or median with lower and upper quartiles. ACEI, angiotensin-converting enzyme inhibitor; AF, atrial fibrillation; AHF, acute heart failure; ALT, alanine transaminase; ARB, angiotensin II receptor blocker; AST, aspartate transaminase; BNP, B-type natriuretic peptide; BP, blood pressure; BUN, blood urea nitrogen; COPD, chronic obstructive pulmonary disease; CRP, C-reactive protein; ECG, electrocardiogram; ED, emergency department; GWTG-HF, Get With The Guidelines-Heart Failure; Hb, hemoglobin; IQR, interquartile range; JVD, jugular vein distention; LVEF, left ventricular ejection fraction; SD, standard deviation; WBC, white blood cell.
deviation or median with lower and upper quartiles as appropriate. Continuous variables were compared by Student’s t-test or the Mann-Whitney U test as appropriate. Categorical variables are expressed as number (percentage) and were compared by the chi-square test or Fisher’s exact test. The Get With The Guidelines-Heart Failure (GWTG-HF) risk score has been described to evaluate the risk of in-hospital death of HF patients with AHF. The GWTG-HF risk score was calculated for each patient as previously described to evaluate the risk of in-hospital death of patients with AHF.¹² The GWTG-HF risk score has been successfully applied in Japanese patients with AHF with good discrimination and calibration.¹³

We performed propensity-score matching to eliminate bias caused by differences in patients’ backgrounds at baseline. The propensity score for each patient was generated using a logistic model constructed with the following variables: age; sex; arrival by ambulance; time of symptom onset; systolic blood pressure (BP); diastolic BP; heart rate; left ventricular ejection fraction; baseline ECG findings; history of hypertension, diabetes, HF, coronary artery disease, and chronic obstructive pulmonary disease; presence of jugular venous distension; rales; pulmonary edema and orthopnea in the ED; prescription of loop diuretics, angiotensin-converting enzyme inhibitors, angiotensin II receptor blockers, β-blockers, and aldosterone blockers at baseline; white blood cell count; hemoglobin; serum sodium; serum creatinine; blood urea nitrogen; and BNP. The Hosmer-Lemeshow goodness-of-fit test was used to check the calibration of the propensity-score model. Propensity-score matching was performed for patients who underwent management by an emergency physician or a cardiologist. These patients underwent one-to-one caliper matching using a caliper width of 20% of the standard deviation of the logit of the calculated propensity score.¹⁴

Standardized mean differences were calculated for all baseline variables to evaluate the balance of the matching, and a difference <0.1 was considered negligible.¹⁵ Kaplan-Meier survival analysis with a log-rank test was used to compare the all-cause death rate between groups. Odds ratio (OR) for dichotomous outcomes and hazard ratio (HR) for survival were calculated with 95% confidence interval (CI). For all analyses, patients managed by a cardiologist were the reference group. To account for intra-institutional correlations among patients, a generalized estimating equation (GEE) model was used before and after propensity-score matching for the outcome of in-hospital death. The GEE model was constructed assuming an exchangeable correlation structure where subjects outcomes from the same center had equal correlation with each other but were uncorrelated with outcomes from subjects in other centers. Additionally, we used robust sandwich variance.

All statistical analyses were performed using R version 3.1.2 (R Foundation for Statistical Computing, Vienna, Austria; https://www.r-project.org), and a two-tailed P-value <0.05 was considered statistically significant.

### Results

### Study Population and Patients’ Characteristics

During the study period, 1,762 patients met the inclusion criteria and were registered in REALITY-AHF. Of these, 80 who met the exclusion criteria were excluded, so 1,682 patients (850 male; mean age, 77 years) remained and comprised the REALITY-AHF cohort. Among these patients, 911 (54.2%) were managed initially by cardiologists as the physician most responsible in the ED, 614 (36.5%) were managed by emergency physicians, and 157 (9.3%) were managed by other physicians. After we had excluded...
157 patients managed by other physicians because of the small sample size. 1,525 patients managed by cardiologists or emergency physicians were analyzed.

The patients’ baseline characteristics are listed in Table 1. Patients cared for by emergency physicians (emergency physician group) were likely to arrive by ambulance and show acute onset of symptoms, and they had a higher systolic BP and heart rate, and lower prevalence of atrial fibrillation, and higher prevalence of hypertension than patients cared for by cardiologists (cardiologist group). Signs of congestion were less frequently present and prescriptions of loop diuretics, angiotensin II receptor blockers, and β-blockers were less prevalent in the emergency physician group than in the cardiologist group. Of the laboratory data, the white blood cell count, alanine transaminase level, and glucose level were significantly higher and the sodium level significantly lower in the emergency physician group than in the cardiologist group. Of the patients’ baseline characteristics were listed in Table 1. Patients cared for by emergency physicians (emergency physician group) were likely to arrive by ambulance and show acute onset of symptoms, and they had a higher systolic BP and heart rate, and lower prevalence of atrial fibrillation, and higher prevalence of hypertension than patients cared for by cardiologists (cardiologist group). Signs of congestion were less frequently present and prescriptions of loop diuretics, angiotensin II receptor blockers, and β-blockers were less prevalent in the emergency physician group than in the cardiologist group. Of the laboratory data, the white blood cell count, alanine transaminase level, and glucose level were significantly higher and the sodium level significantly lower in the emergency physician group than in the cardiologist group. In total, 932 patients were matched based on propensity scores (Table 2). The standardized mean differences were <0.1 for all variables (Supplementary Figure), and the Hosmer-Lemeshow test showed good calibration of the propensity score (P=0.38).

Differences in Treatment for AHF

The selection and timing of treatment for AHF are shown in Table 2. Although the emergency physician group was less likely to use vasodilators and more likely to use NIV and ETI in the first 48 h than was the cardiologist group before matching, these differences did not retain significance after propensity-score matching except for vasodilator use in the first 48 h. In the matched cohort, the rate of vasodilator use was 29.8% for emergency physicians and 46.1% for cardiologists within 90 min of ED arrival. The cumulative usage rate of vasodilators increased to 47.9% in the emergency physician group and 61.7% in the cardiologist group at 6 h after ED arrival, to 52.6% and 64.8% at 24 h after ED arrival, and to 53.6% and 66.5% at 48 h after ED arrival, respectively. Although the usage rates by both types of physicians revealed a generally constant trend, vasodilators were adopted more often by cardiologists than by emergency physicians at all time points (P<0.001).

With regard to treatment with diuretics, the D2F time was shorter in the cardiologist group than in the emergency physician group (104 min vs. 80 min for the emergency physician vs. cardiologist group, respectively; P<0.001). This difference was retained even after propensity-score matching. The rate of patients with a D2F time of <60 min was numerically but not statistically higher in the cardiologist group than in the emergency physician group before propensity-score matching (35.6% vs. 39.6% for the emergency physician vs. cardiologist group, respectively; P=0.162). However, in the matched cohort, significantly more patients were treated with furosemide within 60 min of ED arrival in the cardiologist group than in the emergency physician group (36.2% vs. 45.7%, respectively; P=0.009).

The usage rates of ETI (7.3% vs. 6.0%; P=0.51), intra-aortic balloon pumping (1.5% vs. 2.1%; P=0.62), extracorporeal membrane oxygenation (0.4% vs. 0.2%; P=0.38), and renal replacement therapy (5.8% vs. 6.0%; P=0.99) during hospitalization were comparable between groups after propensity-score matching (Table 3).

Clinical Outcomes

During the index hospitalization, 30 patients (4.9%) initially managed by emergency physicians and 39 patients (4.3%) managed by cardiologists died; no significant difference was found before propensity-score matching (Table 4). Likewise, all-cause in-hospital mortality was not significantly different between groups after propensity-score matching (4.3% vs. 3.9%, OR 1.12; 95% CI 0.58–2.14, P=0.741). We obtained consistent results in the GEE model, in which in-hospital deaths were similar in the 2 groups both before (OR 1.21; 95% CI 0.78–1.87, P=0.400) and after (OR 1.22; 95% CI 0.54–2.66, P=0.626) propensity-score matching. However, hospital stay was significantly shorter in the emergency physician group than in the

### Table 3. Treatment of AHF During Hospitalization

<table>
<thead>
<tr>
<th>Treatment/procedure</th>
<th>Before match</th>
<th>After match</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Emergency physicians (n=614)</td>
<td>Cardiologists (n=911)</td>
<td></td>
</tr>
<tr>
<td>ETI, n (%)</td>
<td>54 (8.8)</td>
<td>48 (5.3)</td>
<td>0.009</td>
</tr>
<tr>
<td>IABP, n (%)</td>
<td>13 (2.1)</td>
<td>11 (1.2)</td>
<td>0.24</td>
</tr>
<tr>
<td>ECMO, n (%)</td>
<td>4 (0.7)</td>
<td>1 (0.1)</td>
<td>0.18</td>
</tr>
<tr>
<td>RRT, n (%)</td>
<td>25 (4.1)</td>
<td>29 (3.2)</td>
<td>0.44</td>
</tr>
</tbody>
</table>

AHF, acute heart failure; ECMO, extracorporeal membrane oxygenation; ETI, endotracheal intubation; IABP, intra-aortic balloon pumping; RRT, renal replacement therapy. Data are presented as number (percentage) of patients.

### Table 4. AHF Patients’ Outcomes During Hospitalization

<table>
<thead>
<tr>
<th>Variables</th>
<th>Before match</th>
<th>After match</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Emergency physicians (n=614)</td>
<td>Cardiologists (n=911)</td>
<td>P value</td>
</tr>
<tr>
<td>In-hospital death, n (%)</td>
<td>30 (4.9)</td>
<td>39 (4.3)</td>
<td>0.58</td>
</tr>
</tbody>
</table>

Reference group is cardiologists’ patients. Data are presented as number (percentage) of patients or median with lower and upper quartiles. AHF, acute heart failure; CI, confidence interval; IQR, interquartile range; OR, odds ratio.
Specialty-Related Differences in AHF Treatment and Prognosis

with AHF ≥24 h after ED presentation during the index hospitalization. We hypothesized that initial management provided by cardiologists may lead to a better prognosis because previous studies have suggested that the prognosis of patients with acute myocardial infarction may improve if management during the first 24 h is provided by cardiologists. However, our study results implied that initial AHF management performed by different specialties yields comparable prognostic outcomes. We might be able to address this question because of the fact that all patients enrolled in REALITY-AHF were finally managed by cardiologists after admission even when the initial management was performed by non-cardiologists. Because we were interested in the outcome differences attributable to differences in initial management, this uniformity might have allowed us to achieve less biased results. Given that proper consultation reportedly improves the prognosis of AHF, our results may support the idea that it is important for cardiologists and emergency physicians to collaborate well but that it is not necessary to decide which specialty should first care for patients with AHF. In addition, this report provides important information in establishing the proper arrangement of doctors in the emergency field.

Interestingly, we found that cardiologists tended to use furosemide and vasodilators earlier than emergency physicians, which implied that earlier management provided by cardiologists instead of emergency physicians translates into a better prognosis. In addition, our previous study demonstrated the association between lower in-hospital mortality and early furosemide administration, or the D2F time. The result that there was no prognostic difference between groups seems contrary to expectation, but the findings of this study do not necessarily contradict our previous findings for the following reasons. On a continuous scale, we observed a 35-min group difference in the D2F time; however, the proportion of patients treated within
60 min differed only by 9.5% between groups. Given the reduction in mortality expected by early treatment (i.e., D2F time <60 min) and low in-hospital mortality in patients with AHF, our analysis was obviously underpowered to detect a difference in in-hospital mortality as a consequence of a group difference in the D2F time. Furthermore, recent reports propose that early intervention with an intravenous vasodilator does not always lead to a reduction of cardiovascular mortality, which supports our finding that early vasodilator administration was not associated with prognosis. In addition, although a prognostic difference was not observed despite differences in the initial drug treatment, this result should not deny the importance of initial management, because the initial drug treatment might not differ enough to result in prognostic difference. Next, there was no difference in the use of NIV and ETI between emergency physicians and cardiologists at any time point in our study. Because delayed decisions regarding invasive respiratory support worsen the prognosis, it is noteworthy that decisions regarding the use of NIV and ETI in both groups were made equally early (at ≤90 min), which is also one of the important findings that explain the lack of difference in prognosis. Additionally, we found no significant difference in the introduction rate of ETI, intra-aortic balloon pumping, extracorporeal membrane oxygenation, or renal replacement therapy during the subsequent phase of hospitalization, which suggests that AHF management by cardiologists during the acute phase does not lead to avoidance of invasive treatment.

Surprisingly, patients with AHF initially managed by cardiologists stayed in hospital longer than those managed by emergency physicians. We have no clear explanation for this finding. However, a previous study showed that cardiologists tend to use IV drugs for congestive HF more aggressively than do doctors of other specialties. In the present study, cardiologists used IV drugs more frequently than did emergency physicians; thus, greater use of IV drugs by cardiologists might lead to longer hospital stays because exposure to such drugs after symptoms have improved would easily prolong the treatment period. However, this hypothesis should be evaluated in future research.

Study Limitations
There are several limitations that need to be addressed. First, all treatments in hospital after initial care in the ED were performed by cardiologists. Although smooth and prompt consultation is considered important for improving clinical outcomes, especially in severe cases when the initial management was carried out by non-cardiologist physicians, we could not fully analyze the effect of the timing of consultation with cardiologists on prognosis. Second, this subanalysis was performed using a prospective observational dataset in Japan. Therefore, the generalizability of our findings might be limited because the medical care system for emergency outpatients may differ among countries. Third, although 20 hospitals, including university hospitals and non-university teaching hospitals, participated this registry in relatively equal proportions, they may not well represent Japanese hospitals that treat patients with AHF, which limits extrapolation of our study results to the whole spectrum of patients with AHF. Finally, institutional differences in management quality might have confounded our study results. However, we tested this bias with a sensitivity analysis using a GEE model and observed consistent results. We believe that the consistency of our analysis results supports our conclusions.

Conclusions
Initial management of AHF in the acute phase differed to some extent between emergency physicians and cardiologists, but these treatment differences did not translate into differences in short- and long-term mortality.

Acknowledgement
None.

Funding Sources
REALITY-AHF was funded by The Cardiovascular Research Fund, Tokyo, Japan. The funding sources had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Declaration of Interest
T.O. has received research grants from Ono Yakuhin, Bayer, Daiichi-Sankyo, Amgen Astellas, and Bristol-Myers outside the submitted work. Y.M. is supported by the Japan Society for the Promotion of Science Overseas Research Fellowships. Y.M. is supported by the Japan Society for the Promotion of Science Overseas Research Fellowships. Y.M. is affiliated with a department endowed by Philips Respironics, ResMed, Teijin Home Healthcare, and Fukuda Denhi, and received an honorarium from Otsuka Pharmaceutical Co., outside the submitted work. K. Yoshida received partial tuition support from Pfizer, Takeda, Bayer, and PhRMA. T. Murohara received lecture fees and unrestricted research grant for the Department of Cardiology, Nagoya University Graduate School of Medicine. From Bayer, Daiichi-Sankyo, Dainippon Sumitomo, Kowa, MSD, Mitsubishi Tanabe, Boehringer Ingelheim, Novartis, Pfizer, Sanofi-Aventis, Takeda, Astellas, Otsuka, and Teijin.

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Supplementary Files

Please find supplementary file(s); http://dx.doi.org/10.1253/ciruj.CJ-18-0724


