ORIGINAL ARTICLE

Factors associated with the need for care escalation in patients with acute heart failure referred from the emergency department to home hospitalization

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Introduction. Home hospitalization (HH) directly from the emergency department (ED) in patients requiring admission is, overall, a safe and effective alternative. However, in some cases, HH requires escalation of care, and the patient must be transferred to the hospital to complete treatment under conventional inpatient care. This study analyzes the factors associated with the need for such escalation in patients with acute heart failure (AHF).

Method. Two hospitals reviewed patients with AHF admitted to HH over a 3-year period. Escalation of care was defined as transfer from HH to the hospital to complete inpatient treatment, regardless of cause. The association between escalation need and 24 baseline variables as well as 24 variables from the decompensation episode was evaluated, both crudely and in adjusted analyses. Variables significant in both models were included in a final global multivariable model.

Results. A total of 367 patients admitted to HH from the ED for AHF were analyzed (median age, 86 years; 53% women). Escalation of care occurred in 52 cases (14%). The only baseline variable independently and inversely associated with the need for escalation was admission to an HH unit where joint evaluation between HH and emergency professionals was conducted to assess HH eligibility. Among the decompensation episode variables, hyponatremia and creatinine > 1.3 mg/dL were directly associated with escalation. These three variables remained significant in the final global model, with adjusted ORs of 0.373 (95% CI, 0.193–0.731), 2.634 (95% CI, 1.196–5.798), and 3.507 (95% CI, 1.80–6.835), respectively.

Conclusions. The need for escalation in patients with AHF admitted to HH directly from the ED occurs in a moderate percentage of cases and is associated with renal impairment and hyponatremia at admission. Joint participation of HH and emergency professionals in the decision-making process for HH admission reduces the risk of treatment failure in these patients.

Keywords: Home hospitalization. Emergency department. Acute heart failure. Adverse event.

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Factores asociados a la necesidad de escalada asistencial en pacientes con insuficiencia cardiaca aguda derivados desde urgencias a hospitalización a domicilio

Objetivos. La hospitalización a domicilio (HAD) directamente desde urgencias en pacientes que requieren ingreso es una alternativa eficiente y segura de manera global. Sin embargo, en algunos casos la HAD precisa de escalada asistencial y el paciente debe ser trasladado al hospital para completar el tratamiento en régimen de hospitalización convencional. Este estudio analiza los factores asociados a esta necesidad de escalada asistencial en pacientes con insuficiencia cardiaca aguda (ICA).

Método. Dos hospitales revisaron los pacientes con ICA que ingresaron en HAD durante un periodo de 3 años. Se definió como necesidad de escalada asistencial el traslado desde HAD al centro hospitalario para completar hospitalización, independientemente del motivo. Se evaluó, de forma cruda y ajustada, la asociación entre la necesidad de dicha escalada con 24 variables basales y con 24 variables del episodio de descompensación. Las variables significativas en ambos modelos se incluyeron en un modelo global multivariable final.

Resultados. Se analizaron 367 pacientes ingresados en HAD desde urgencias por ICA (edad mediana: 86 años; 53% mujeres). Hubo escalada asistencial en 52 casos (14%). La única variable basal asociada de forma independiente e inversa a la necesidad de escalada asistencial fue el ingreso en una unidad de HAD en la que existía valoración previa conjunta entre los profesionales de HAD y los de urgencias en cuanto a la pertinencia del ingreso en HAD, y entre las variables del episodio de descompensación, se asociaron de forma directa la hiponatremia y una creatinina > 1,3 mg/dL. Estas tres variables mantuvieron asociaciones significativas en el modelo global final, con OR ajustadas de 0,373 (IC 95%: 0,193-0,731), 2,634 (IC 95%: 1,196-5,798), y 3,507 (IC 95%: 1,80-6,835), respectivamente.

Conclusiones. La necesidad de escalada en pacientes con ICA ingresados en HAD directamente desde urgencias ocurre en un porcentaje moderado de casos y se asocia con insuficiencia renal e hiponatremia al ingreso. La participación de los profesionales de HAD juntamente con los del servicio de urgencias en la decisión de ingreso en HAD disminuye el riesgo de fracaso en estos pacientes.

Palabras clave: Hospitalización a domicilio. Urgencias. Insuficiencia cardiaca aguda. Evento adverso.

Introduction

Heart failure (HF) poses a growing challenge for health care systems. In Spain, recent figures indicate that the prevalence of HF ranges between 1.8% and 2.0%, with an annual incidence rate of approximately 2.8 new patients per 1,000 inhabitants, as reported by the PATHWAYS-HF study using data from 2017–2019.[1] Decompensations in these chronic patients, known as acute heart failure (AHF), are particularly significant because they constitute the main cause of hospitalization among people older than 65 years and are associated with high morbidity, mortality, and deterioration in quality of life.[2] In Spain, approximately 80,000 hospital admissions due to AHF occur every year, representing about 5% of all hospitalizations in older adults.[3] Most decompensated patients present to emergency departments (EDs) due to worsening of their symptoms, and 3 out of 4 end the urgent care episode with a hospital admission.[4,5] Thus, admissions from the ED are the main route of hospitalization for patients with AHF. These admissions last an average of 7 days in Spain,[6] and in-hospital mortality ranges between 5% and 10%.[7]

In the Spanish context, these figures support interest in alternative models of care such as hospital-at-home (HaH). HaH allows the provision of intensive hospital-level care in the patient's home environment.[9] Several studies have demonstrated the safety and efficacy profile of the HaH model in patients with AHF. Among them, a controlled clinical trial conducted in older patients showed similar clinical outcomes between HaH and conventional hospitalization at the 1-year follow-up, accompanied by a considerable reduction in costs.[10] Furthermore, evidence such as that from the EAHFE registry has confirmed the feasibility and effectiveness of implementing HaH programs directly from the ED in Spain.[11] However, determinants of success or failure of these programs still require clarification, especially among frail patients or those with high comorbidity. A primary care study in Barcelona (Catalonia, Spain) found that among HF patients receiving home care, factors such as male sex and severe functional dependence were associated with higher mortality and hospitalization.[12]

The objective of the present study is to analyze the clinical, functional, and sociodemographic factors associated with HaH failure in AHF patients admitted directly from the ED in the clinical context of 2 Spanish hospitals.

Method

Study design

Two EDs participated in this study: those of Hospital Clínic de Barcelona (Barcelona, Spain) and Hospital General Universitario Dr. Balmis de Alicante (Alicante, Spain). These centers identified all patients diagnosed with AHF who were admitted directly to HaH between March 2016 and February 2019 (a total of 3 years). Patient inclusion characteristics followed the methodology of the EAHFE Registry[13] and were based on the clinical diagnosis of AHF according to the Framingham criteria,[14] later confirmed by natriuretic peptides or echocardiography in those patients for whom these data were available, following the European Society of Cardiology clinical practice guidelines.[15] Data collection was conducted retrospectively through review of health records, as detailed in a previous joint study from both centers.[11] Re-attendance after discharge was considered a new episode of AHF and was included if the patient was admitted to HaH.

The HaH unit at *Hospital Clínic* began operating in 2006 and currently cares for approximately 2,600 patients per year. The multidisciplinary team consists of 9 internal medicine physicians, nurses, physiotherapists, pharmacists, social workers, and administrative staff, providing 24/7 coverage. It reports functionally to the Medical and Nursing Directorates. In general, after initial evaluation, diagnosis, and treatment initiation, the patient is transferred to the ED observation unit, where clinical evolution is monitored for a few hours (< 24). If no improvement occurs and hospitalization is required, the ED physician checks whether conditions for HaH admission are met and, if so, refers the patient to the HaH team for evaluation. If criteria are met, both teams (HaH and ED) agree to transfer the patient home the same day or the next, depending on HaH availability. On average, the time between ED arrival and effective home hospitalization is 12 to 24 hours.

The HaH unit at *Hospital General Universitario Dr. Balmis de Alicante* is administratively dependent on the ED, though functionally independent, and its professionals—who provide care at patients' homes—are not part of the ED and have their own professional category. After initial assessment, diagnosis, and treatment in the ED, if improvement is absent or partial and hospitalization is required, the ED physician determines whether the patient meets HaH criteria, without HaH team participation in that decision. If appropriate, the patient is transferred home at any time of day. Upon ED discharge, a referral to HaH is issued so that professionals can begin home visits. On average, the time between ED arrival and effective HaH hospitalization is 8 to 12 hours.

Independent variables

A total of 48 independent variables were collected, divided into 2 groups. On the one hand, baseline characteristics (24 variables), including 3 epidemiological variables (age, sex, ED assessment by HaH professionals), 11 comorbidities (hypertension, diabetes mellitus, ischemic heart disease, atrial fibrillation, chronic kidney disease, valvular heart disease, chronic obstructive pulmonary disease, dementia, neoplasm, stroke, prior AHF episodes), 5 chronic treatments (loop diuretics, beta-blockers, renin-angiotensin system inhibitors—RASi, aldosterone receptor blockers—ARB), 6 baseline func-

tional status variables (NYHA functional class, left ventricular ejection fraction—LVEF, Barthel index, falls in the previous 6 months, sphincter incontinence, visual or hearing impairment). On the other hand, acute episode variables (24 variables), including 5 precipitating factors (infection, tachyarrhythmia, anemia, hypertensive crisis, dietary/pharmacological non-adherence), 8 clinical features (exertional dyspnea, pulmonary crackles, lower-limb edema, orthopnea, jugular venous distention, paroxysmal nocturnal dyspnea, signs of low output, hepatomegaly), 3 vital signs (systolic blood pressure, heart rate, baseline pulse oximetry), 5 laboratory parameters (hemoglobin, creatinine, sodium, potassium, NT-proBNP), 3 chest X-ray characteristics (cardiomegaly, alveolar edema in lung parenchyma, pleural effusion). Time elapsed between ED arrival and home transfer under HaH conditions.

Outcome variables

The study outcome variable was the need for escalation of care from HaH. This was defined as the need for the patient to return to the hospital to continue inpatient care, regardless of the reason for transfer. HaH was considered successful if it ended with patient discharge, regardless of duration. Due to the objectivity of this outcome, event adjudication was performed by the site's principal investigator without external review. The time between HaH admission and return to the hospital due to escalation was recorded, as well as the primary reason for return.

Statistical analysis

Categorical variables were expressed as frequencies and percentages, and continuous variables were as median and interquartile range (IQR). For comparisons between patients with successful vs failed HaH, categorical variables were analyzed using the chi-squared test or Fisher's exact test, as appropriate; continuous variables were analyzed using the nonparametric Mann–Whitney test.

To estimate the size of association between independent variables and the need for escalation of care, odds ratios (OR) with 95% confidence intervals (CI) were calculated using logistic regression. First, crude ORs were calculated for all 50 independent variables. Two multivariable models were then constructed: Model 1: included age, sex, and baseline variables with $P < .10$ in univariate analysis. Model 2: included acute episode variables with $P < .10$ in univariate analysis. Using this strategu, djusted ORs were obtained independently for each model. These multivariable models were repeated twice: first using only cases with valid values for all included variables and then including all cases using multiple imputation with chained equations to replace missing data. The Mersenne Twister was used as the pseudorandom number generator with seed 2,000,000 to generate 10 datasets without missing values.

A global multivariable adjustment model (Model 3) was then constructed, including variables that were statistically significant in Models 1 and 2, as well as age and sex. Model 3 was developed using the multiple imputation datasets. For variables significantly associated with escalation, first-order interaction with hospital site *(Hospital Clínic de Barcelona or Hospital General Universitario Dr. Balmis)* was assessed.

Finally, Kaplan–Meier survival curves were used to depict the occurrence of events (escalation of care) over time in the study population. Subgroup analyses were performed for factors independently associated with escalation, and differences between subgroups were evaluated using the log-rank test.

In all comparisons, tatistical significance was set at $P < .05$ or when the 95% CI for the OR excluded 1. Statistical analyses were performed using SPSS version 24.0 for Windows (IBM Corp.) and STATA version 16 (StataCorp LLC).

Ethical considerations

The ethical principles of the Declaration of Helsinki on research involving human subjects were followed. The protocol of the EAHFE Registry was approved by the Clinical Research Ethics Committee of the 2 participant hospitals.

Results

A total of 367 patients diagnosed with AHF who were referred directly from the ED to the HaH program were included, of whom 182 came from *Hospital Clínic* de Barcelona and 185 from *Hospital Universitario Dr. Balmis in Alicante* (Figure 1). The median length of the

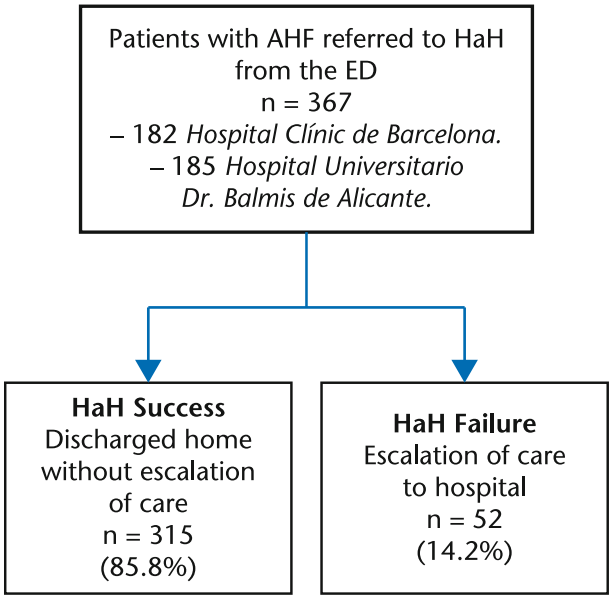

Figure 1. Flow diagram of patient inclusion.
AHF: acute heart failure; HaH: hospital-at-home.

Table 1. Baseline characteristics of the patients included in the study

	All patients N = 367 n (%)	Missing values n (%)	HaH Success N = 315 n (%)	HaH Failure N = 52 n (%)	*P*
Epidemiological data					
Age [median (IQR)]	86 (80-90)	0	86 (80-90)	86 (82-90)	.925
Age ≥ 90 years	90 (19.2)		80 (25.4)	10 (19.2)	.338
Female sex	189 (52.8)	9 (2.5)	168 (54.7)	21 (41.2)	.073
Type of HaH		0			**< .001**
With participation in admission decision (*Hospital Clínic,* Barcelona)	182 (49.6)		167 (53.0)	15 (28.8)	
Without participation in admission decision (*Hospital Dr. Balmis,* Alicante)	185 (50.4)		148 (47.0)	37 (71.2)	
Comorbidities					
Previous episodes of acute heart failure	288 (90.9)	50 (13.6)	246 (90.4)	42 (93.3)	.533
Hypertension	317 (87.1)	3 (0.8)	275 (87.9)	42 (82.4)	.277
Atrial fibrillation	221 (60.7)	3 (0.8)	198 (63.3)	23 (45.1)	**.014**
Diabetes mellitus	148 (40.7)	3 (0.8)	125 (39.9)	23 (45.1)	.486
Chronic kidney disease (creatinine > 2 mg/dL)	132 (36.3)	3 (0.8)	110 (35.1)	22 (43.1)	.271
Ischemic heart disease	128 (35.2)	3 (0.8)	103 (32.9)	25 (49.0)	**.025**
Valvular heart disease	118 (32.4)	3 (0.8)	104 (33.2)	14 (27.5)	.414
Chronic obstructive pulmonary disease	101 (27.7)	3 (0.8)	85 (27.2)	16 (31.4)	.533
Neoplasm	79 (21.7)	3 (0.8)	68 (21.7)	11 (21.6)	.980
Stroke	61 (16.8)	3 (0.8)	50 (16.0)	11 (21.6)	.321
Dementia	46 (12.6)	3 (0.8)	42 (13.4)	4 (7.8)	.266
Chronic home treatment					
Loop diuretics	276 (78.4)	3 (0.8)	236 (75.4)	40 (78.4)	.639
Renin–angiotensin system inhibitors	188 (51.6)	3 (0.8)	165 (52.7)	23 (45.1)	.313
Beta-blockers	180 (49.5)	3 (0.8)	153 (48.9)	27 (52.9)	.591
Aldosterone receptor antagonists	78 (21.4)	3 (0.8)	67 (21.4)	11 (21.6)	.979
Baseline functional status					
NYHA FC III–IV	68 (20.6)	37 (10.1)	59 (20.6)	9 (20.5)	.979
LVEF (%) [median (IQR)]	51 (40-60)	169 (46.0)	51 (40-60)	55 (37-55)	.941
Barthel Index [median (IQR)]	85 (55-100)	26 (7.1)	85 (55-100)	85 (50-95)	.279
Falls at home (previous 6 months)	49 (14.5)	28 (7.6)	43 (14.7)	6 (12.8)	.723
Sphincter incontinence	53 (15.4)	23 (6.3)	48 (16.2)	5 (10.6)	.330
Limiting visual or hearing impairment	34 (10.0)	26 (7.1)	30 (10.2)	4 (8.7)	.756

LVEF: Left ventricular ejection fraction; HaH: Hospital at home; NYHA: New York Heart Association; IQR: Interquartile range.
Bold values denote statistical significance ($P < .05$).

HaH stay was 9 days (IQR, 7–14), with no differences between the 2 centers [9 (7–13) and 10 (6–16) days, respectively; $P = .446$]. Patients were of advanced age (median 86 years), slightly more than half were women (52.8%), and comorbidities were frequent, with notable prevalences of previous AHF episodes (90.9%), hypertension (87.1%), and atrial fibrillation (60.7%). Loop diuretics were prescribed in 78.4% of patients, and about half received beta-blockers and renin–angiotensin system inhibitors. A total of 75% of patients had some functional limitation (Barthel Index < 100), 60% had preserved LVEF, and 21% were in NYHA class III–IV. Additional characteristics are shown in Table 1.

Regarding the decompensation episode, the main precipitating factor was infection (41.0%). The most common symptoms and signs were dyspnea (89.9%), pulmonary crackles (72.0%), and lower-limb edema (70.0%). Fewer than 10% presented hypotension (SBP < 100 mmHg) on arrival to the ED, and the median pulse oximetry oxygen saturation was 95%. Elevated creatinine levels (> 1.3 mg/dL) were recorded in 41.6% of patients, hyponatremia (< 135 mmol/L) in 26.0%, and NT-proBNP levels > 5,000 pg/mL in 46.6%. Radiologically, the most frequent finding was cardiomegaly (77.5%), and pleural effusion was present in 39.8%. The median length of the ED stay for patients admitted to HaH was 6 hours (IQR, 5–16), with significant differences between centers (*Hospital Clínic de Barcelona* 17 hours, IQR, 14–22; *Hospital General Universitario Dr. Balmis* 5 hours, IQR, 3–7; $P < .001$). Additional characteristics are shown in Table 2.

Of the 367 patients in this study, 315 (85.8%) completed HaH successfully without requiring escalation of care, whereas 52 patients (14.2%) required escalation. For these patients, the median time until return to the hospital was 7 days (IQR, 4–14 days). This need for escalation was higher in the HaH program where HaH professionals did not participate in the admission decision (*Hospital Dr. Balmis,* Alicante; 35 cases, 20.0%) vs the program in which HaH professionals jointly participated with emergency physicians in decision-making (*Hospital Clínic,* Barcelona; 17 cases, 8.2%; $P < .001$). However, no differences were observed in the median time spent in HaH before the patient required return to the hospital for conventional hospitalization: 7 days (IQR, 4–18) at the 1st center and 6 days (IQR, 5–9) at

Table 2. Characteristics of the decompensation episode in the patients included in the study

	All patients N = 367 n (%)	Missing values n (%)	HaH Success N = 315 n (%)	HaH Failure N = 52 n (%)	*P*
Episode triggers					
Infection	142 (41.0)	21 (5.7)	126 (42.3)	16 (33.3)	.242
Tachyarrhythmia	37 (10.7)	21 (5.7)	32 (10.7)	5 (10.4)	.947
Anemia	33 (9.5)	21 (5.7)	28 (9.4)	5 (10.4)	.823
Hypertensive crisis	15 (4.3)	21 (5.7)	13 (4.4)	2 (4.2)	.951
Dietary/pharmacological non-adherence	13 (3.8)	21 (5.7)	10 (3.4)	3 (6.3)	.328
Clinical presentation					
Exertional dyspnea	321 (89.9)	10 (2.7)	277 (90.2)	44 (88.0)	.628
Pulmonary crackles	257 (72.0)	10 (2.7)	220 (71.7)	37 (74.0)	.733
Lower-limb edema	250 (70.0)	10 (2.7)	216 (70.4)	34 (68.0)	.736
Orthopnea	159 (44.5)	10 (2.7)	136 (44.3)	23 (46.0)	.822
Jugular venous distention	68 (19.0)	10 (2.7)	60 (19.5)	8 (16.0)	.554
Paroxysmal nocturnal dyspnea	60 (16.8)	10 (2.7)	52 (16.9)	8 (16.0)	.869
Signs of low cardiac output	23 (6.5)	12 (3.3)	20 (6.6)	3 (6.0)	.882
Hepatomegaly	6 (2.0)	10 (2.7)	5 (1.6)	1 (2.0)	.850
Vital signs in ED					
Systolic blood pressure (mmHg) [median (IQR)]	133 (116-151)	13 (3.5)	135 (117-152)	128 (105-139)	.062
Hypotension (< 100 mmHg)	34 (9.6)		27 (8.8)	7 (14.6)	.208
Heart rate (bpm) [median (IQR)]	80 (69-92)	28 (7.6)	80 (68-92)	80 (71-94)	.692
Baseline pulse oximetry (%) [median (IQR)]	95 (93-97)	18 (4.9)	95 (93-97)	96 (91-98)	.889
Laboratory data					
Hemoglobin (g/dL) [median (IQR)]	11.7 (10.3-12.9)	11 (3.0)	117 (103-129)	115 (104-127)	.482
Creatinine (mg/dL) [median (IQR)]	1.23 (0.94-1.68)	11 (3.0)	1.19 (0.91-1.60)	1.69 (1.20-2.19)	< **.001**
Creatinine > 1.3 mg/dL	148 (41.6)		114 (37.3)	34 (68.0)	< **.001**
Sodium (mmol/L) [median (IQR)]	140 (137-143)	10 (2.7)	140 (137-143)	138 (134-141)	< **.001**
Hyponatremia (< 135 mmol/L)	44 (26.0)		31 (10.1)	13 (26.0)	**.002**
Potassium (mmol/L) [median (IQR)]	4.2 (3.8-4.6)	16 (4.4)	4.3 (3.9-4.7)	4.1 (3.8-4.4)	.311
NT-proBNP (pg/mL) [median (IQR)]	4,277 (2,185-11,635)	161 (43.9)	3,938 (1,853-9,731)	7,933 (2,965-25,370)	**.014**
NT-proBNP > 5,000 pg/mL	96 (46.6)		75 (43.4)	21 (63.6)	**.032**
Radiographic findings					
Cardiomegaly	269 (77.5)	20 (5.4)	234 (78.8)	35 (79.0)	.168
Alveolar edema in lung parenchyma	35 (10.1)	20 (5.4)	32 (10.8)	3 (6.0)	.300
Pleural effusion	138 (39.8)	20 (5.4)	116 (39.1)	22 (44.0)	.509

HaH: Hospital at home; IQR: Interquartile range.
Bold values denote statistical significance ($P < .05$).

the 2nd ($P = .594$). Causes for escalation (return from HaH to hospital to resume conventional hospitalization) are summarized in Table 3, with the main cause being worsening HF (34.6%), followed by fever (11.5%), arrhythmias (9.6%), falls at home (7.7%), and acute coronary syndrome (5.8%). No significant differences were found in age (median 84 years in both groups; $P = .925$) or in the proportion of women (54.7% in the success group vs 41.2% in the failure group; $P = .073$). Patients requiring escalation had less frequent atrial fibrillation (63.3% vs 45.1%, $P = .014$) and more frequent ischemic heart disease (49.0% vs 32.9%; $P = .025$). No differences were observed in other comorbidities, nor in chronic treatment prior to decompensation, nor in baseline functional status (Table 1). Regarding characteristics of the decompensation episode, patients who required escalation more frequently presented elevated creatinine, hyponatremia, and NT-proBNP values > 5,000 pg/mL (Table 2).

In the multivariable model exploring baseline characteristics associated with the need for escalation (Model 1), of the 5 selected candidate variables, only 1 showed an independent and inverse association with escalation: the decision for HaH admission being made jointly by the emergency physician and the HaH professional (Table 4). On the other hand, in the multivariable model that included 4 characteristics of the decompensation episode (Model 2), 2 variables were directly associated with HaH escalation: hyponatremia and elevated creatinine (> 1.3 mg/dL) (Table 4). The final global model (Model 3), which included variables that were significant in Models 1 and 2, as well as age and sex, showed that the variables retaining statistical significance were the HaH model in which the admission decision was shared by ED and HaH professionals (adjusted OR, 0.373; 95% CI, 0.191–0.731), hyponatremia (OR, 2.633; 95% CI, 1.196–5.798), and elevated creatinine (OR, 3.507; 95% CI, 1.800–6.835) (Figure 2). No interaction was observed between the HaH model and the 2 latter factors independently associated with escalation ($P = .491$ for hyponatremia and $P = .525$ for elevated creatinine). The survival analysis is shown in Figure 3, where the variables associated with escalation (type of decision, hyponatremia, and elevated creatinine) were also associated with significantly different survival curves.

Table 3. Causes leading to the need for escalation of care in patients admitted to hospital-at-home (return to hospital to continue treatment under conventional hospitalization)

	All N = 52 n (%)	*Hospital General Universitario Dr. Balmis* (Alicante) N = 35 n (%)	*Hospital Clínic* (Barcelona) N = 17 n (%)
Worsening of heart failure	18 (34.6)	12 (34.3)	6 (35.3)
Fever	6 (11.5)	5 (14.3)	1 (5.9)
Arrhythmia	5 (9.6)	2 (5.7)	3 (17.6)
Fall at home	4 (7.7)	2 (5.7)	2 (11.8)
Acute coronary syndrome	3 (5.8)	1 (2.9)	2 (11.8)
Anemia	2 (3.8)	2 (5.7	0 (0)
Acute cholecystitis	1 (1.9)	0 (0)	1 (1.9)
Confusional syndrome	1 (1.9)	1 (2.9)	0 (0)
Clinical deterioration	1 (1.9)	1 (2.9)	0 (0)
Abdominal pain	1 (1.9)	1 (2.9)	0 (0)
Upper GI bleeding	1 (1.9)	1 (2.9)	0 (0)
Hyperglycemia	1 (1.9)	1 (2.9)	0 (0)
Ischemic stroke	1 (1.9)	1 (2.9)	0 (0)
Surgical wound infection	1 (1.9)	1 (2.9)	0 (0)
Renal failure	1 (1.9)	1 (2.9)	0 (0)
Medication overdose	1 (1.9)	1 (2.9)	0 (0)
Pulmonary thromboembolism	1 (1.9)	1 (2.9)	0 (0)
Not identified	3 (5.8)	1 (2.9)	2 (11.8)

Discussion

The present study, focused on patients with AHF referred from the ED to HaH, reveals that approximately 14% required escalation of care, defined as the need for conventional hospitalization after initiating a HaH regimen. Although the main reason for escalation was worsening HF, this occurred in just over one-third of the cases, while the remainder were due to diverse circumstances. In the multivariable analysis, 3 independent factors were identified as being associated with HaH failure: admission to a HaH unit without prior assessment by the team that would subsequently assume the patient's care; the presence of hyponatremia; and creatinine > 1.3 mg/dL at admission. These findings have clear clinical implications for improving patient selection and optimizing program outcomes.

There is limited evidence regarding HaH programs specifically designed for AHF. A 2015 systematic review identified six studies comparing outcomes of HaH with those of conventional hospitalization in AHF patients, several of which were suitable for meta-analysis.[16] No significantly beneficial impact of HaH was observed on mortality [reported in 3 studies, with a pooled OR of 0.94 (95% CI, 0.67–1.32)] or on rehospitalization [reported in 2 studies, pooled OR, 0.68 (95% CI, 0.42–1.09)]. However, the total number of ED visits and hospitalizations declined, and quality of life improved long-term in the HaH group. A subsequent 2021 meta-analysis evaluating two randomized controlled trials comparing HaH and conventional hospitalization found a pooled OR for mortality of 0.87 (95% CI, 0.38–1.98).[17] Beyond HaH-specific evidence, other studies have evaluated home-based care (though not under a hospitalization model) in HF. Muñoz et al. demonstrated that, among elderly patients receiving home care, dependence in activities of daily living and comorbidity were associated with mortality and hospitalization.[12] Similarly, Stevenson et al. published a systematic review on multidisciplinary home-care strategies in HF, highlighting their ability to reduce hospital admissions and improve care among high-risk patients.[18] Another relevant context is unscheduled returns after AHF episodes. Rizzi *et al.,* in the EAHFE Registry, identified factors such as dementia, functional dependence, chronic kidney disease, or hypertension as being associated with in-hospital mortality or 90-day readmissions.[19]

To date, factors associated with HaH failure in AHF had not been investigated. Both hyponatremia[20,21] and renal insufficiency[22,23] are well-established markers of poor prognosis in AHF. The association of moderate renal dysfunction (elevated creatinine) and hyponatremia with HaH failure suggests that patients with fluid–electrolyte imbalance and renal dysfunction may have

Table 4. Crude and adjusted analysis of the association between baseline variables (Model 1) and acute decompensation episode variables (Model 2) with the need for escalation of care in hospital-at-home

	Crude OR (95% CI)	Adjusted OR (95% CI)* (without imputation)	Adjusted OR (95% CI)* (with imputation)
Model 1: Model with baseline variables			
HaH with participation of HaH team in admission decision	**0.359 (0.190-0.681)**	**0.321 (0.162-0.633)**	**0.327 (0.169-0.364)**
Ischemic heart disease	**1.960 (1.079-3.563)**	**2.041 (1.058-3.939)**	1.907 (0.992-3.666)
Age ≥ 90 years	0.699 (0.335-1.458)	0.709 (0.317-1.588)	0.754 (0.348-1.635)
Female sex	0.579 (0.317-1.057)	0.672 (0.349-1.297)	0.692 (0.360-1.328)
Atrial fibrillation	0.477 (0.262-0.867)	0.544 (0.289-1.021)	0.564 (0.302-1.052)
Model 2: Model with acute decompensation variables			
Creatinine > 1.3 mg/dL	**3.579 (1.891-6.772)**	**2.862 (1.240-6.607)**	**3.319 (1.698-6.489)**
Hyponatremia (< 135 mmol/L)	**3.128 (1.503-6.510)**	**3.921 (1.557-9.874)**	**2.978 (1.382-6.417)**
NT-proBNP > 5,000 pg/mL	**2.287 (1.058-4.940)**	1.930 (0.835-4.466)	1.389 (0.665-2.901)
Hypotension (< 100 mmHg)	1.764 (0.722-4.312)	1.478 (0.393-5.554)	1.196 (0.462-3.093)

*Adjustment was performed in independent partial models for baseline characteristics and for acute decompensation characteristics.
OR: odds ratio; CI: confidence interval; HaH: hospital-at-home.
Bold values denote statistical significance ($P < .05$).

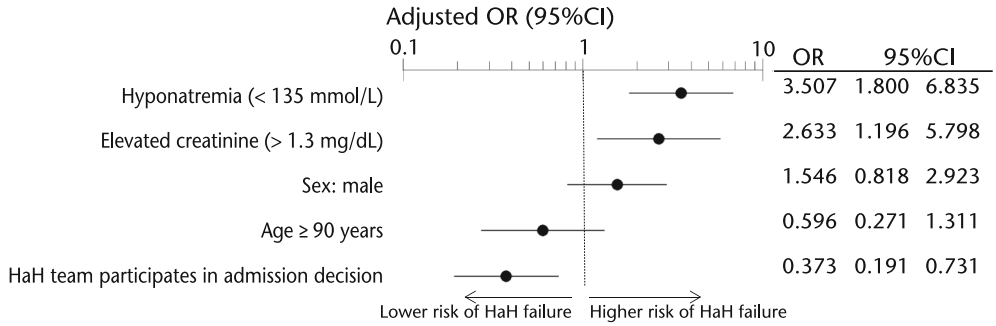

Figure 2. Global adjusted analysis (Model 3) of the need for escalation of care in hospital-at-home.
OR: odds ratio; CI: confidence interval; HaH: hospital-at-home.

greater physiological frailty and congestion, limiting the feasibility of exclusive home-based management. These parameters may also identify patients with a more compromised hemodynamic profile or persistent congestion, who may benefit from more intensive inpatient monitoring. This is particularly true for creatinine, since the initiation of decongestion may be accompanied by transient, non-prognostic rises in this biomarker. In any case, sodium and creatinine are variables available at admission and can be used for safer selection of HaH candidates.

Equally notable is the lower need for escalation of care in HaH units where the admission decision is shared with the HaH team that will assume the patient's care. This may be related to greater care integration, improved coordination between ED and HaH teams, and more precise patient selection. This factor could also be associated with longer observation time in the ED within this coordinated model, although it is impossible to discern the specific relative contributions of shared decision-making versus extended observation. In any case, this finding underscores the importance of organizational integration in the selection and monitoring of patients.

The external validity of our findings must be interpreted within the framework of the Spanish health care system, where the organization of AHF care is heterogeneous. Only one-third of hospitals have on-call cardiologists or HF units, and access to diagnostic tools and continuity-of-care resources varies widely across centers

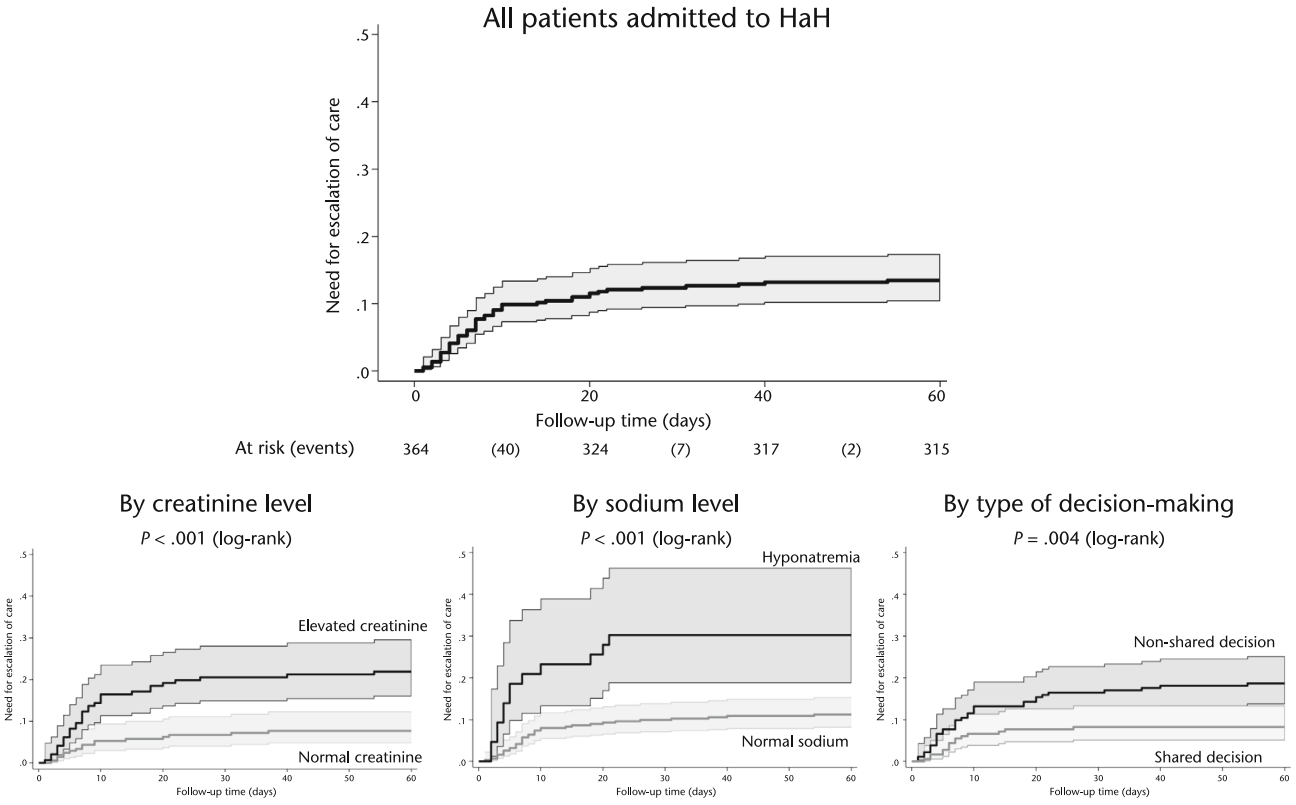

Figure 3. Analysis of the need for escalation of care using Kaplan–Meier survival curves for all patients in the sample (top) and for subgroups defined by variables significantly associated with escalation of care in the global adjusted model (Model 3).
HaH: hospital-at-home.

and autonomous communities.[8] Furthermore, this study includes a very elderly and frail population, typical in real-world practice, which may limit generalizability to settings with different resource availability or patient profiles. Nonetheless, the results highlight the need to strengthen continuity of care and harmonize ED organization to facilitate implementation of HaH programs for AHF in Spain.

These findings have clinical implications. First, HaH can reduce pressure on inpatient beds for patients requiring hospitalization from the ED, while also shortening ED boarding times. In Spain, these times are often prolonged and associated with a higher frequency of adverse outcomes.[24-26] Therefore, given that HaH has repeatedly demonstrated safety and efficiency,[9-11] its broader implementation should be encouraged. To improve HaH outcomes in AHF patients, renal function and serum sodium should be considered as decision-making criteria when selecting candidates from the ED. In high-risk patients, protocolized monitoring—either through remote monitoring or intensive home follow-up—should be implemented. The development of integrated scoring tools incorporating clinical, functional, and analytical variables could also enable earlier and more accurate selection. Finally, these results suggest that multidisciplinary evaluation by the HaH team and joint decision-making with ED physicians may reduce the risk of failure.

The most notable limitation of this study is the moderate sample size and relatively low number of events (need for escalation), which may limit statistical power in some analyses. Forty-eight variables were analyzed with 52 events, and although inclusion was filtered by a significance threshold of $P < .10$ and partial models were used, the risk of model overfitting remains. Propensity score adjustment was not performed to avoid further reduction in sample size. Additionally, despite the large number of variables included, factors such as adequate family support, therapeutic adherence, or socioeconomic considerations—which may influence HaH success—were not captured. Differences between the 2 models are not fully explained, although the main cause of escalation, worsening HF, was the most frequent in both centers and occurred at nearly identical proportions. Furthermore, results may not be generalizable to centers without established HaH units or with different organizational structures. Lastly, functional factors such as dependence or cognitive impairment were not independently associated in the global analysis, despite being well-documented predictors of poorer outcomes. This may be due to collinearity with analytical or logistical variables or to the relatively limited sample size, which—as discussed—reduces statistical power and increases the possibility of type II error.

In conclusion, the need for escalation of care in HaH initiated from the ED in AHF patients occurs in a moderate proportion of cases and is mainly associated with renal insufficiency and hyponatremia at HaH admission. Units in which HaH professionals participate jointly with ED clinicians in admission decisions may have a lower risk of failure. These findings underscore the need to establish robust and homogeneous clinical criteria for HaH referral in AHF patients, as well as to promote integrated organizational models that ensure a safe transition from the ED to the home. External validation of these findings and the development of predictive tools adapted to this specific context should be priorities for future research.

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