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Acute decompensated heart failure in the emergency department

Identification of early predictors of outcome

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Abstract

Identification of clinical factors that can predict mortality and hospital early readmission in acute decompensated heart failure (ADHF) patients can help emergency department (ED) physician optimize the care-path and resource utilization.

We conducted a retrospective observational study of 530 ADHF patients evaluated in the ED of an Italian academic hospital in 2013.

Median age was 82 years, females were 55%; 31.1% of patients were discharged directly from the ED (12.5% after short staying in the observation unit), while 68.9% were admitted to a hospital ward (58.3% directly from the ED and 10.6% after a short observation). At 30 days, readmission rate was 17.7% while crude mortality rate was 9.4%; this latter was higher in patients admitted to a hospital ward in comparison to those who were discharged directly from the ED (12.6% vs. 2.4%, $P<.001$). Thirty-day mortality was significantly related to older age, higher triage priority, lower mean blood pressure (MBP), and lower pulse oxygen saturation (POS). At 180 days, crude mortality rate was 23.2%, higher in admitted patients compared with discharged ones (29.6% vs. 9.1%, $P<.001$) and was significantly related to older age, higher serum creatinine, and lower MBP and POS. At 12 and 22 months, crude mortality rates resulted 30.4% and 45.1%, respectively.

Simple and objective parameters, such as age ≤82 years, MBP > 104 mm Hg, POS > 94%, may guide the ED physician to identify low-risk patients who can be safely discharged directly from the emergency room or after observation unit stay.

Abbreviations: ACS = acute coronary syndrome, ADHF = acute decompensated heart failure, ASL = local health department, BMI = body mass index, CI = confidence interval, COPD = chronic obstructive pulmonary disease, CRF = chronic renal failure, ED = emergency department, EMR = electronic medical records, HF = heart failure, HR = hazard ratio, IQR = interquartile range, MBP = mean blood pressure, OU = observation unit, POS = pulse oxygen saturation.

Keywords: acute decompensated heart failure, emergency department, mortality predictors, outcome, readmission predictors, risk stratification

1. Introduction

Heart failure (HF) is a clinical syndrome typically manifesting with fluid retention, dyspnea, and fatigue, which may limit exercise tolerance.[1] In developed countries, HF affects approximately 1% to 2% of the adult population and >10% of the elderly, thus represents a major, global public health challenge.[2] Although our ability to manage HF has improved in the last few decades, recent data confirm that approximately 50% of HF patients die within 5 years from diagnosis.[3]

HF course is often interspersed by episodes of acute decompensated heart failure (ADHF), followed by worsening of ventricular function. Symptoms of these patients accrue over time, severely impairing function, and quality of life. ADHF episodes prompt frequent emergency department (ED) accesses and hospital admissions that may herald death, usually due to pump failure or ventricular arrhythmia.[4] The early diagnosis and the immediate start of the appropriate treatment are both needed in the approach of ADHF patients in the ED.[5] However, ED physicians face the additional challenge of identifying those patients who need hospital admission from those who can be safely discharged. In fact, unnecessary hospitalizations increase costs and put the patients at risk of hospital-related complications, while inappropriate early discharges put patients at increased risk of adverse outcomes.[6] ED observation units (OUs) are an efficient tool to solve this conundrum.[7] As far as the postdischarge event rates remain low,[8] diagnosis and treatment of ADHF in OU is highly cost-effective, particularly for those patients who require <24 h care.[9] However, the difficulty of discharging patients presenting with ADHF directly from the ED is demonstrated by the wide variations observed in the direct discharge rate in different countries, being low (16%) in the United States,[10] intermediate (24–33%) in Spain,[11,12] and high (36%) in Canada.[13] Unfortunately, information on this topic in other countries, including Italy, is either scarce or lacking.

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In the present paper, we aimed at investigating short- and long-term mortality of patients visiting the ED for ADHF, as well as admission and discharge rates, ED revisit or hospital readmission rates, and possible independent predictors of safe direct discharge. To accomplish these tasks, we analyzed data of all patients receiving an ED visit for ADHF in an Academic Hospital of Northern Italy during solar 2013.

2. Methods

2.1. Design and setting

This retrospective observational study was conducted in the "AOU Maggiore della Carità" University General Hospital, Novara, Italy. Data were obtained by interrogating the electronic medical records (EMRs) of all patients visiting the ED between January 1, 2013 and December 31, 2013. The index event was defined as the first ED access due to HF in 2013. To identify HF admissions, the International Classification of Diseases code "428*"[14] within the first 4 diagnosis positions and/or the keyword "failure" for the verbatim of diagnosis entered by the ED physician were used. This allowed us to select a cohort of 641 EMRs. In order to avoid selection bias, an expert ED physician reviewed each individual EMR selected to confirm or exclude ADHF in agreement with Framingham criteria.[15] We excluded 111 patients for whom ADHF was not considered the most relevant clinical problem causing the ED access and/or for whom data on follow-up could not be retrieved with certainty being they resident outside the Novara Local Health Department (ASL NO) area. This process led us to a final cohort of 530 patients. The study was conducted according to the guidelines of the local ethical committee and in conformity to the principles of the Declaration of Helsinki.

2.2. Data sources

Data were retrieved from EMRs, the Regional Register of Piedmont, and the hospital data base of discharged patients. The EMRs consulted (PSNET, Hitech spa, Firenze, Italy) contain all personal and clinical data of ED patients, including ED outcome (i.e., short-term observation in OU, discharge at home, hospitalization, or death). The Regional Register of Piedmont is a database containing demographic and administrative data about the entire resident population entitled to receive National Health Service benefits in the Region. The discharge records database of the "Maggiore della Carità" University General Hospital enables retrieval of data on patients admitted to hospital ward, including length of stay, in-hospital mortality, and final diagnosis.

2.3. Demographic and clinical features of the patient population

Demographic characteristics, clinical parameters at ED access, triage color code, comorbidities, and ED outcome regarding the index event were analyzed. Clinical parameters including mean blood pressure (MBP), pulse oxygen saturation (POS) in room air breathing, and heart rate were collected during triage. The triage color code assigned by the triage nurses determined the visit priority, a red tag meaning "need of immediate evaluation," a yellow tag "observation and possible later re-triage," and a green tag "wait." Following the ED visit, the patients were either discharged, admitted to the OU, or admitted to a hospital ward. Time in the ED was calculated as hours from triage entry to ED discharge. Serum creatinine concentration at the index event visit was also collected.

Comorbidities were investigated taking into account both the ED EMR and the discharge records from the hospital ward. Specifically, we assessed the presence of the following conditions: personal history of atrial fibrillation (all forms), previous episodes of acute coronary syndrome (ACS), diabetes, hypertension, chronic obstructive pulmonary disease (COPD), and chronic renal failure (CRF). Obesity, evaluated through measurement of body mass index (BMI), was defined as a BMI $\geq$30 kg/m^2.

2.4. Outcomes

We determined the crude mortality rates at 30 days, 180 days, 12 months, and 22 months, being the censor date October 31, 2015. Furthermore, we calculated the direct discharge rate from the ED, as well as the OU transit and hospitalization rates, and measured occurrence and timing of first ED revisits and/or first readmissions to hospital wards after the index event.

2.5. Statistical analysis

Statistical analysis of data was conducted using the Stata/IC software package, rel. 13.1 (StataCorp LP, College Station, TX). Throughout the paper, the measures of central tendency and dispersion for continuous variables were medians and interquartile ranges (IQRs), while differences among groups with regard to these variables were tested either by the Mann–Whitney or the Kruskal–Wallis test, as appropriate. Categorical variables were presented as frequencies (%), while associations between them were tested either by the Fisher exact test or the Pearson chi-squared test, as appropriate. Survival times were calculated starting on the day of the index event (first ED visit in solar year 2013). The log-rank test was used to identify groups with different survival probabilities, graphically presented in Kaplan–Meier plots; hazard ratios (HRs) and relative 95% confidence intervals (CIs) were also calculated. Finally, a Cox proportional hazard model was built to analyze the weight of predictors found at univariate analysis (we entered in the model variables whose P value was $<$.10). The level of significance chosen for all statistical tests was 0.05 (2-tailed).

3. Results

3.1. Index event and patients' disposal

The study population included 530 ADHF patients, of whom 290 were females (55%). The median age of the study population was 82 years (IQR 75–87). Women were significantly older than men (84 years, IQR 79–88 vs. 80 years, IQR 73–85, $P<.001$). Table 1 summarizes demographic characteristics, clinical parameters, and comorbidities of patients in the studied cohort, recorded at the index event. In this regard, missing data were the following: MBP for 16 patients, HR for 12 patients, POS for 16 patients, and serum creatinine value for 5 patients. Out of 530 of patients, 365 (69%) were admitted to a hospital ward; 56/365 patients (15.3% of admitted patients and 10.6% of the whole cohort) a short stay at the OU preceded hospital admission. Three-hundred nine patients (84.7% of admitted patients and 58.3% of the whole cohort) were directly admitted to hospital ward after the ED evaluation. Out of 530 patients, 165 (31.1%) were discharged from ED either to be sent home or to a long-term facility; 66/165 (40% or 12.5% of the whole cohort) of patients who were discharged from the ED had

Table 1

Main demographic and clinical features of the study population.

	Total (N=530)	Admitted (N=365)	Discharged (N=165)	P
M/F	240 (45%)/290 (55%)	167 (46%)/198 (54%)	73 (44%)/92 (56%)	.778
OU transit	122 (23%)	56 (15%)	66 (40%)	**<.001**
Age, y	82 (75–87)	82 (75–87)	81 (75–87)	.732
Triage color code				**<.001**
Red	39 (7%)	37 (10%)	2 (1%)	
Yellow	307 (58%)	249 (68%)	58 (35%)	
Green	184 (35%)	79 (22%)	105 (64%)	
Time in ED, h	5 (3–12)	5 (3–8)	9 (4–25)	**<.001**
MBP, mm Hg	104 (92–117)	104 (93–117)	105 (92–117)	.825
Heart rate, per min	85 (70–101)	87 (70–105)	80 (67–93)	**.002**
POS	94 (89–96)	92 (88–96)	95 (92–97)	**<.001**
Atrial fibrillation	254 (48%)	174 (48%)	80 (48%)	.925
Previous ACS	176 (33%)	124 (34%)	52 (32%)	.619
Hypertension	366 (69%)	243 (67%)	123 (75%)	.069
Obesity	123 (23%)	83 (23%)	40 (24%)	.739
Diabetes	173 (33%)	119 (33%)	54 (33%)	1.000
COPD	171 (32%)	116 (32%)	55 (33%)	.764
CRF	129 (24%)	95 (26%)	34 (21%)	.191
Creatinine, mg/dL	1.06 (0.82–1.48)	1.13 (0.84–1.56)	1.01 (0.80–1.32)	**.011**

Data are presented for the whole population, patients admitted, and patients discharged from the ED. Continuous variables are presented as medians and interquartile range; categorical variables are presented as frequencies (%). The *P* values refer to the comparison between admitted and discharged groups using the Wilcoxon rank-sum test, the Fisher exact test, or the Pearson chi-squared test, as appropriate. The statistically significant *P* values are reported in bold.

ACS=acute coronary syndrome, COPD=chronic obstructive pulmonary disease, CRF=chronic renal failure, ED=emergency department, MBP=mean blood pressure, OU = observation unit, POS=pulse oxygen saturation.

stayed in the OU. Therefore, out of 530 patients, 122 (23%) visited the OU before being either admitted (N=56) or discharged (N=66). Six of these 122 patients refused hospital admission. None of the patients died in the ED.

Red and yellow tag patients were represented disproportionately in the hospital admitted group in comparison to the discharged group (10% vs. 1% and 68% vs. 35%, respectively, $P<.001$ for both comparisons). Moreover, 22% of the admitted patients had a green tag assigned at triage, in comparison to the 64% of patients that were subsequently discharged ($P<.001$). Time in ED increased from a median of 5h (IQR 3–8) in the admitted group up to 9h (IQR 4–25) in the discharged group ($P<.001$). Creatinine value was higher in the admitted group (1.13 mg/dL vs. 1.01 mg/dL, $P=.011$). MBP and comorbidities did not differ in the 2 groups. Heart rate and POS were the only vital signs with statistically significant differences in the 2 groups, as reported in Table 1.

Kaplan–Meier plots, shown in Fig. 1, present survival estimates at 30 days (A) and at the end of follow-up (B) either among patients admitted to a hospital ward (N=365) or among those discharged directly from ED after index visit (N=165).

3.2. Early revisit and readmission rates

After 30 days from the index event, 17.7% of the patients incurred in an ED revisit or a new hospital readmission. In the revisited/readmitted group, heart rate at the index event was significantly lower (80 bpm vs. 86 bpm, $P=.042$) while serum creatinine was higher (1.18 mg/dL vs. 1.02 mg/dL, $P=.028$). Among other variables, only previous ACS (44% vs. 31%, $P=.022$) and CRF (33% vs. 22%, $P=.035$) were significantly more prevalent in this group.

3.3. Predictors of 30-day mortality

The crude 30-day mortality rate was 9.4% (N=50). The results of the univariate analysis showed no differences in mortality between males and females. Patients who died within 30 days from the index event were older (median age 84 vs. 82, $P<.001$) and had been more commonly assigned either to a red or yellow triage color code. Moreover, MBP (98 mm Hg vs. 105 mm Hg, $P<.001$) and POS (89% vs. 94%, $P<.001$) were lower while creatinine (1.3 mg/dL vs. 1.0 mg/dL, $P<.001$) was higher in patients who died early. Heart rate and time spent in ED did not differ between the latter patients and survivors (see Table 2). Analyzing patients based on triage color code, the 30-day mortality rates were 23% for red tag patients, 10.4% for yellow tag, and 4.9% for green tag. Moreover, splitting the data on patients' disposal (discharge vs. admission), we observed a 2.4% 30-day mortality rate for ED discharged patients and 12.6% for admitted patients ($P<.001$).

Atrial fibrillation (30% vs. 50%, $P=.011$) and obesity (10% vs. 25%, $P=.021$) were less represented among patients who died within 30 days from the index event; hypertension (56% vs. 70%, $P=.052$), and COPD (20% vs. 34%, $P=.057$) had a similar trend, although statistical significance was not reached.

The 30-day incidence rate of death varied from 3.73 per 1000 person-days (95% CI 2.82–4.93; N=49 events in 13,127 days) to 0.54 (95% CI 0.076–3.84, N=1 event in 1848 days) according to the following 3 factors: age (cut-off value: 82 years), MBP (cut-off value: 104 mm Hg), and POS (cut-off value: 94%). The corresponding incidence ratio was 0.145 (95% CI 0.003–0.847, $P=.006$).

The Cox proportional hazard regression model (summarized in Table 3) identified as independent predictors of 30-day mortality age (HR=1.045), MBP (HR=0.959), POS (HR=0.943), and a history of COPD (HR=0.417).

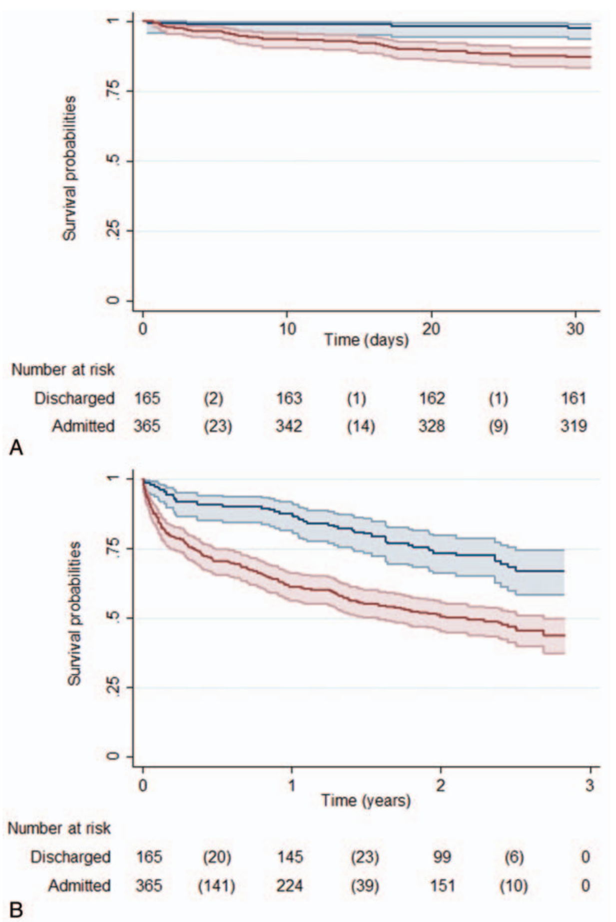

Figure 1. Kaplan–Meier survival estimates of being dead at 30 days (A) and at the end of follow-up (B). Red lines indicate patients admitted to hospital after the index visit at the ED, blue lines those discharged after the ED visit. Shaded areas represent 95% confidence intervals. Numbers in parenthesis indicate failures. ED = emergency department.

3.4. Predictors of 180-day mortality

The crude mortality rate at 180 days was 23.2% (N = 123/530). Again, splitting data on the bases of patients' allocation, we observed a 9.1% 180-day mortality rate for ED discharged patients and 29.6% for admitted patients ($P < .001$).

Patients who died within 180 days from the index event were older (83 years vs. 81 years, $P < .001$), but the triage color code distribution did not differ between them and those who survived beyond 180 days. Regarding MBP and POS, univariate analysis showed lower values among patients dead at 180 days: 99 mm Hg vs. 107 mm Hg ($P < .001$) and 91% vs. 94% ($P = .004$), respectively. Creatinine was again higher among who died early (1.3 mg/dL vs. 1.0 mg/dL, $P < .001$). Obesity resulted more prevalent in survivors (15% vs. 26%, $P = .01$) while the other comorbidities and the time spent in ED showed no differences between the 2 groups (Table 2).

Age (HR = 1.031), MBP (HR = 0.979), POS (HR = 0.957), creatinine (HR = 1.242), and history of hypertension (HR = 0.646) were significant independent predictors of death within 180 days after index event with Cox proportional hazard regression model (Table 3).

3.5. Long-term follow-up

After a minimum follow-up period of about 22 months (668 days), the total number of patients who died was N = 239/530 (45.1%); 161 patients died within the first year, leading to a crude 1-year mortality rate of 30.4%. In comparison to patients discharged from ED after the index visit, the relative risk of being dead for patients admitted to hospital was 5.6 (95% CI 2.0–15.4) at 30 days, 3.8 (95% CI 2.2–6.6) at 180 days, 4.0 (95% CI 2.5–6.4) at 1 year, and 2.4 (95% CI 1.8–3.3) at the end of the follow-up (see also Fig. 1B).

4. Discussion

With the present study, we provide a contemporary snapshot of patients accessing an ED for ADHF, of their disposal by ED physicians, and of their outcomes shortly after the index event as well as in the long term. At triage, age, POS, and MBP identify patients with very low 30-day mortality. These findings will be discussed at the light of the existing literature on the topic.

The first finding worth mentioning is that the median age in the study population was 82 years, indicating that nowadays among patients presenting to the ED with ADHF there are many belonging to the "oldest old" category. Specifically, the population in the present study was on average almost 10-year older than those enrolled in other ED HF registries (i.e., 73 years for ADHERE[16] and 72 years for ATTEND[17]). Likely, these differences from previous studies stem from the combined effect of the continuous ageing of the population (it should not be forgotten that Italy has the second highest aging index among European countries) and of the success in controlling factors predisposing to HF, such as hypertension and coronary artery disease. Despite the advanced age of patients, we observed a 30-day crude mortality rate of 9.4%, similar to those observed in other studies.[11,18] The 1-year crude mortality rate was 30.4% in the entire cohort and rose to 38.6% considering only the patients admitted to a hospital ward, again similar to the value observed by Joffe et al in their analysis of in-hospital patients.[18] On the other hand, among patients directly discharged from the ED, the 1-year mortality rate fell to 12.1%. This confirms the overall correct risk stratification operated in the ED.

The median time spent in the ED was longer for patients who were eventually discharged directly from the ED than for those who were admitted to a hospital ward (in approximately 60% of cases, an internal medicine division, data not shown). A significantly larger proportion of patients who were directly discharged from the ED had been managed in an OU, confirming the clinical judgment of ED physicians that these patients were more likely to improve quickly. The observation time allowed them to treat the acute phase of HF, to verify the stability of the patients, to optimize the therapy, to improve patient education, and to arrange postdischarge care.[9,19,20]

The overall direct discharge rate from ED was 31.1% (including those discharged after an OU stay), a value under the target of 40% proposed by Mirò et al for ED provided with an OU.[20] Nevertheless, the observed rate was markedly higher than the value previously reported in other countries (16% for the United States[10] and 24% for Spain[11]). Moreover, the 30-day revisit or hospital readmission rate observed in our study (17.7%) was well below the target value of 20% suggested as quality criteria.[20] Clinical history of previous ACS, renal function impairment (both anamnestic CRF and creatinine higher value),

Table 2

Comparison of the characteristics of patients, categorized into different groups according to 30- and 180-day mortalities.

	Dead at 30 d (N=50)	Alive >30 d (N=480)	P	Dead at 180 d (N=123)	Alive >180 d (N=407)	P
M/F	28 (56%)/22 (44%)	212 (44%)/268 (56%)	.135	58 (47%)/65 (53%)	182 (45%)/225 (55%)	.680
Discharged/admitted	4 (8%)/46 (92%)	161 (34%)/319 (66%)	**<.001**	15 (12%)/108 (88%)	150 (37%)/257 (63%)	**<.001**
Age, y	84 (82–90)	82 (75–86)	**<.001**	83 (80–89)	81 (74–86)	**<.001**
Triage color code			**.001**			.193
Red	9 (18%)	30 (6%)		13 (11%)	26 (6%)	
Yellow	32 (64%)	275 (57%)		73 (59%)	234 (57%)	
Green	9 (18%)	175 (36%)		37 (30%)	147 (36%)	
Time in ED, h	5 (3–8)	5 (3–12.5)	.324	5 (3–11)	6 (3–12)	.437
MBP, mm Hg	98 (83–105)	105 (93–118)	**<.001**	99 (87–110)	107 (94–120)	**<.001**
Heart rate, per min	82 (66–105)	85 (70–101)	.630	82 (66–100)	85 (70–102)	.310
POS	89 (85–94)	94 (89–96)	**<.001**	91 (86–96)	94 (89–96)	**.004**
Atrial fibrillation	15 (30%)	239 (50%)	**.011**	52 (42%)	202 (50%)	.181
Previous ACS	17 (34%)	159 (33%)	.876	44 (36%)	132 (32%)	.513
Hypertension	28 (56%)	338 (70%)	.052	77 (63%)	289 (71%)	.095
Obesity	5 (10%)	118 (25%)	**.021**	18 (15%)	105 (26%)	**.010**
Diabetes	11 (22%)	162 (34%)	.113	33 (27%)	140 (34%)	.125
COPD	10 (20%)	161 (34%)	.057	37 (30%)	134 (33%)	.584
CRF	8 (10%)	121 (25%)	.163	35 (28%)	94 (23%)	.232
Creatinine, mg/dL	1.3 (1.1–1.7)	1.0 (0.8–1.5)	**<.001**	1.3 (1.0–1.8)	1.0 (0.8–1.4)	**<.001**

Continuous variables are presented as medians (interquartile range), and categorical variables are presented as frequencies (%). The *P* values refer to the comparison between the 2 groups at the Wilcoxon rank-sum test, the Fisher exact test, or the Pearson chi-squared test, as appropriate. The statistically significant *P* values are reported in bold.
ACS=acute coronary syndrome, COPD=chronic obstructive pulmonary disease, CRF=chronic renal failure, ED=emergency department, MBP=mean blood pressure, POS=pulse oxygen saturation.

and lower heart rate were associated with increased rate of revisit or readmission.

Among vital signs, only reduced MBP and POS were related to 30-day mortality. The finding that a higher MBP in this setting portends a favorable outcome in the short-term makes sense, and is consistent with evidence indicating that in ADHF hypotension associated with increased mortality.[21] POS is known to be a reliable indicator of arterial blood oxygen concentration,[22] and may usefully contribute to the assessment of both diagnosis and prognosis in ADHF due to myocardial infarction.[23] Our data confirm and strengthen the prognostic role of POS for patients presenting with ADHF and this was confirmed even selecting patients on the base of the presence or not of a clinical history of COPD (data not shown). This may have relevant clinical implications, helping physician to identify patients at high risk on which hospital resources need to be directed, and providing the rationale for stricter follow-up.

An unexpected finding in our study was the protective role attributed to comorbidities, such as obesity and atrial fibrillation ($P<.05$), but lightly also for hypertension and COPD ($P<.10$) at the univariate analysis of factors associated with 30-day mortality. This apparent paradox was confirmed at multivariate analysis only for COPD at 30 days and for arterial hypertension when 180 days follow-up time was considered. However, our

Table 3

Cox proportional hazard regression model of factors associated with 30- and 180-day mortality.

	Factor	Hazard ratio	95% Confidence interval		P
30 d	Hypertension*	0565	0.303	1.05	.072
	Obesity*	0.474	0.185	1.217	.121
	COPD*	0.417	0.195	0.896	**.025**
	Age†	1.045	1.010	1.081	**.012**
	MBP†	0.959	0.942	0.976	**<.001**
	POS†	0.943	0.902	0.987	**.011**
	Creatinine†	1.184	0.979	1.434	.082
	Triage color code‡	0.586	0.304	1.129	.110
180 d	Hypertension*	0.646	0.436	0.959	**.030**
	Obesity*	0.668	0.400	1.118	.125
	Age†	1.031	1.009	1.054	**.005**
	MBP†	0.979	0.969	0.990	**<.001**
	POS†	0.957	0.931	0.983	**.001**
	Creatinine†	1.242	1.096	1.408	**.001**

This table shows the hazard ratios resulted from multivariate analysis. Variables were selected if their *P* values at univariate analysis of 30- and 180-day mortality was <.10. The statistically significant *P* values are reported in bold.
COPD=chronic obstructive pulmonary disease, MBP=mean blood pressure, POS=pulse oxygen saturation.
* Categorical variables.
† Continuous numerical variables.
‡ Ordinal variables (red 1; yellow 2, and green 3).

findings are at variance with those of a recent, large multicentre study from the United States, in which in-hospital death rates for patients with and without COPD were similar, whereas the 5-year survival rate of ADHF was 40% worse for patients with concomitant COPD.[24] It might be noted, in turn, that the 2 studies share the observation that COPD is not a negative prognostic factor for short-term survival of patients presenting with ADHF. It could be speculated that COPD exacerbations (by definition, a confounder in this setting) may bring the patient with HF to the hospital, but may also benefit from short-term measures such as antibiotic therapy with comparatively better survival, and that, generally speaking, control of comorbidities and better nutritional status may positively affect survival of ADHF in the short-term. Furthermore, part of the differences between the 2 studies may be explained considering that both are limited by the inability of quantifying the severity of COPD, likely a major factor influencing the extent to which the latter condition influences survival of ADHF patients.

Impaired renal function is a well-documented predictor of in-hospital and postdischarge mortality in patients with ADHF.[25–27] Less data are available about its role in ED's cohorts and about identifying low-risk patients, and that is a field on which further analysis are being carried out. For instance the score EHMRG proposed by Lee et al, which contains creatinine among its variable, it is used to predict 7-day mortality after ED visit.[28]

Our data, based on the evaluation of serum creatinine concentration during the index event, allowed us to confirm previously reported data since increased creatinine concentration resulted an independent predictor of 180-day mortality. Plasma creatinine concentration resulted significantly associated with hospitalization and 30-day mortality at univariate analysis but this significance was not confirmed in multivariate analysis using Cox proportional hazard model. In other words, plasma creatinine proved to be an important independent predictor of mortality at mid-term, less so at short-term.

Mortality at 30 days, 180 days, 12 months, and 22 months was significantly and consistently better among patients who were directly discharged from ED after the index event than among patients admitted to a hospital ward. Therefore, the judgment made by ED physicians on clinical grounds proved to be correct. Patients aged 82 years or less, who had an MBP >104 mm Hg and a POS >94% had very low 30-day incidence death rates. Interestingly, POS was significantly lower among patients who were admitted to a hospital ward after the ED visit, while MBP and age were not. In theory, a putative rule of thumb including all 3 the above-mentioned parameters may improve the clinical decision making of ED physicians, for example encouraging them to pursue ADHF management in OU, which may further increase the direct discharge rate.

4.1. Study limitations

The major limitations of our study stem from his retrospective design. Selection bias could represent a problem; even if we tried to reduce it (e.g., using validation by ED expert), it is possible that this has not been completely eliminated. Moreover, we had to deal with some missing data for a few variables used in our analysis and we have not been able to collect other variables that could have been of interest (specifically, BNP and ejection fraction). We also had the possibility to assess only mortality from any cause and not the mortality for specific causes such as HF and related conditions; the same is true for ED revisits and readmissions. A prospective cohort study would avoid these biases and limitations and might validate our results.

5. Conclusions

Direct discharge rates from the ED of patients presenting with ADHF remain below the ideal 40% threshold, although they are approaching it. Simple vital parameters routinely obtained at triage, such as MBP and POS, may identify—in the ageing population typically affected by ADHF in developed countries—those patients who may benefit of focused care in OU, aimed to rapid improvement and direct discharge from the ED, with considerable savings.

References

[1] Yancy CW, Jessup M, Bozkurt B, et al. 2013 ACCF/AHA guideline for the management of heart failure: executive summary: a report of the American College of Cardiology Foundation/American Heart Association Task Force on practice guidelines. Circulation 2013;128: 1810–52.

[2] Mosterd A, Hoes AW. Clinical epidemiology of heart failure. Heart 2007;93:1137–46.

[3] Mozaffarian D, Benjamin EJ, Go AS, et al. Heart disease and stroke statistics—2015 update: a report from the American Heart Association. Circulation 2015;131:e29–322.

[4] McMurray JJ, Adamopoulos S, Anker SD, et al. ESC guidelines for the diagnosis and treatment of acute and chronic heart failure 2012: the Task Force for the Diagnosis and Treatment of Acute and Chronic Heart Failure 2012 of the European Society of Cardiology. Developed in collaboration with the Heart Failure Association (HFA) of the ESC. Eur Heart J 2012;33:1787–847.

[5] Peacock WF, Mueller C, Disomma S, et al. Emergency department perspectives on B-type natriuretic peptide utility. Congest Heart Fail 2008;14(suppl 1):17–20.

[6] Miró Ò, Peacock FW, McMurray JJ, et al. European Society of Cardiology—Acute Cardiovascular Care Association position paper on safe discharge of acute heart failure patients from the emergency department. Eur Heart J Acute Cardiovasc Care 2017;6:311–20.

[7] Peacock WF, Fonarow GC, Ander DS, et al. Society of Chest Pain Centers recommendations for the evaluation and management of the observation stay acute heart failure patient—parts 1–6. Acute Card Care 2009;11: 3–42.

[8] Collins SP, Lindsell CJ, Naftilan AJ, et al. Low-risk acute heart failure patients: external validation of the Society of Chest Pain Center's recommendations. Crit Pathw Cardiol 2009;8:99–103.

[9] Schrager J, Wheatley M, Georgiopoulou V, et al. Favorable bed utilization and readmission rates for emergency department observation unit heart failure patients. Acad Emerg Med 2013;20:554–61.

[10] Storrow AB, Jenkins CA, Self WH, et al. The burden of acute heart failure on U.S. Emergency Departments. JACC Heart Fail 2014;2:269–77.

[11] Llorens P, Escoda R, Miró O, et al. Characteristics and clinical course of patients with acute heart failure and the therapeutic measures applied in Spanish emergency departments: based on the EAHFE registry (Epidemiology of Acute Heart Failure in Emergency Departments). Emergencias 2015;27:11–22.

[12] Miró O, Gil V, Herrero P, et al. Multicentric investigation of survival after Spanish emergency department discharge for acute heart failure. Eur J Emerg Med 2012;19:153–60.

[13] Brar S, McAlister FA, Youngson E, et al. Do outcomes for patients with heart failure vary by emergency department volume? Circ Heart Fail 2013;6:1147–54.

[14] WHO. International Classification of Diseases, Ninth Revision. World Health Organization. Available from: http://www.cdc.gov/nchs/icd/icd9.htm. Accessed June 19, 2013.

[15] McKee PA, Castelli WP, McNamara PM, et al. The natural history of congestive heart failure: the Framingham study. N Engl J Med 1971;285: 1441–6.

[16] Fonarow GC, Heywood JT, Heidenreich PA, et al. Temporal trends in clinical characteristics, treatments, and outcomes for heart failure hospitalizations, 2002 to 2004: findings from Acute Decompensated Heart Failure National Registry (ADHERE). Am Heart J 2007;153: 1021–8.

[17] Sato N, Kajimoto K, Asai K, et al. Acute Decompensated Heart Failure Syndromes (ATTEND) registry. A prospective observational multicenter cohort study: rationale, design, and preliminary data. Am Heart J 2010;159:949–55.
[18] Joffe SW, Webster K, McManus DD, et al. Improved survival after heart failure: a community-based perspective. J Am Heart Assoc 2013;2:e000053.
[19] Storrow AB, Collins SP, Lyons MS, et al. Emergency department observation of heart failure: preliminary analysis of safety and cost. Congest Heart Fail 2005;11:68–72.
[20] Miró Ò, Levy PD, Möckel M, et al. Disposition of emergency department patients diagnosed with acute heart failure: an international emergency medicine perspective. Eur J Emerg Med 2017;24:2–12.
[21] Patel PA, Heizer G, O'Connor CM, et al. Hypotension during hospitalization for acute heart failure is independently associated with 30-day mortality: findings from ASCEND-HF. Circ Heart Fail 2014;7:918–25.
[22] Masip J, De Mendoza D, Planas K, et al. Peripheral venous blood gases and pulse-oximetry in acute cardiogenic pulmonary oedema. Eur Heart J Acute Cardiovasc Care 2012;1:275–80.
[23] Masip J, Gayà M, Páez J, et al. Pulse oximetry in the diagnosis of acute heart failure. Rev Esp Cardiol (Engl Ed) 2012;65:879–84.
[24] Fisher KA, Stefan MS, Darling C, et al. Impact of COPD on the mortality and treatment of patients hospitalized with acute decompensated heart failure: the Worcester Heart Failure Study. Chest 2015;147:637–45.
[25] De Luca L, Fonarow GC, Adams KF, et al. Acute heart failure syndromes: clinical scenarios and pathophysiologic targets for therapy. Heart Fail Rev 2007;12:97–104.
[26] Fonarow GC, Adams KF, Abraham WT, et al. Risk stratification for in-hospital mortality in acutely decompensated heart failure: classification and regression tree analysis. JAMA 2005;293:572–80.
[27] Aronson D, Mittleman MA, Burger AJ. Elevated blood urea nitrogen level as a predictor of mortality in patients admitted for decompensated heart failure. Am J Med 2004;116:466–73.
[28] Lee DS, Stitt A, Austin PC, et al. Prediction of heart failure mortality in emergent care: a cohort study. Ann Intern Med 2012;156:767–75.