RESEARCH PAPER

Predictors of 1-year outcome in very old patients managed in a Heart Failure Unit after an acute decompensation

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Key summary points

Aim We analyzed the predictors of prognosis in very old HF patients managed in a Heart Failure Unit after an acute decompensation.

Findings In a very old cohort of patients (mean age 89 years), those living alone and with an EVEREST score > 4 had a poor prognosis with a steeper descendent Kaplan–Meier curve during 1-year follow-up.

Message Residual congestion and social isolation as living alone identify those patients with high risk of 1-year death.

Abstract

Purpose Consensus exits about the clinical benefits of an early referral to multidisciplinary Heart Failure Unit-HFU for old frail patients with HF. Nevertheless, few data are present regarding the prognosis and the predictors of outcome in oldest–old patients managed in this clinical setting. The aim of present study is to identify predictors of 1-year all-cause mortality in very old patients enrolled in our multidisciplinary HFU after an episode of acute decompensated HF.

Methods This study is a retro-prospective, single-center cohort analysis of patients managed in our multidisciplinary HFU. Inclusion criterion was diagnosis of HF according to ESC guidelines and age ≥ 85 years, while no exclusion criteria were pre-defined. Baseline clinical and comprehensive geriatric evaluations were recorded during the first visit and follow-up visits were repeated according to our standardized timetable protocol. Primary end-point was 1-year all-cause mortality.

Results We enrolled 75 patients aged 89.2 ± 2.8 years; 39 (52.0%) were females. During 1-year follow-up, seventeen patients (22.7%) died. Residual congestion with higher level (> 4) of EVEREST score (HR 1.24: 95% CI 1.04–1.47) and living alone (HR 3.34: 95% CI 1.16–9.64) resulted the two independent predictors of 1-year all-cause mortality at the multivariate Cox regression model. Finally, patients living alone and with an EVEREST score > 4 experienced a worse prognosis as clearly described by a steeper descendent Kaplan–Meier curve.

Conclusion In a very old population of patients after an acute decompensated HF, residual congestion and social isolation as living alone identify those with high risk of 1-year death.

Keywords Chronic heart failure · Elderly · Mortality · Functional status · Heart Failure Unit

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Introduction

Heart failure [HF] is one of the main public health problems worldwide, affecting around 38 million people [1], including 15 million in Europe [2]. In the last decades, we registered a significant increase in HF prevalence and incidence, due to the contemporary association between growing in aging population and significant improve of survival after an acute cardiovascular syndrome [3]. HF epidemiology is deeply changing over time, moving toward a higher prevalence of HF with preserved than reduced ejection fraction [4], affecting more often comorbid frail older patients [5]. In patients admitted for HF, in-hospital mortality is very high, ranging from 5 to 15% or more, and among patients who survive to discharge, a further 10–15% will die within 6–12 weeks [6]; in the OPTIMIZE-HF Study [7], the 60- to 90-day post-discharge mortality rate was 8.6%. Predictors of early post-discharge mortality included age, serum creatinine, reactive airway disease, liver disease, lower systolic blood pressure, lower serum sodium, lower weight, and depression [7]. Nevertheless, other clinical variables, such as frailty [8] or self-care ability [9], both strictly related to geriatric domains, seem to influence negatively the outcome in very old patients. In addition, an early re-hospitalization after acute decompensated HF is frequent and strongly marks the prognosis [10]. Therefore, the first 15–30 days after discharge commonly defined as transition phase [11] represent a high event risk period, during which, all efforts should be put to maintain the clinical stability obtained during hospital stay and to tailor the best long-term HF program of care for each patient [12]. In this view, current ESC guidelines for the management of patients with HF recommend a clinical evaluation within 7–15 days from hospital discharge and a long-term health program [13]. Real-world data suggest that a relevant number of patients are discharged too early after acute decompensated HF with residual systemic and pulmonary congestion and without referral to a post-acute program of care [14]. Based on these clinical evidences, different modalities of post-discharge continuum care programs have shown to improve short- and long-term prognosis in HF patients [15]. Although conflicting data are present [16], general consensus exists about the beneficial effect of post-discharge referral to a Heart Failure Unit-HFU particularly for those patients with a complex vulnerable profile or frailty, when the organization of local health care system provides this option [16]. In very old adults, sporadic research evidences are concentrated in acute setting after an episode of worsening HF and data show the prognostic value of geriatric domains such as functional capacity as reported in RICA study [17]; this study demonstrated the independent predictive power of Barthel index in 273 nonagenarians during 90-day follow-up period [17]. Conversely, few data are focused on predictors of long-term prognosis in very old outpatients managed in HFU.

Thus, the aim of this study is to identify predictors of all-cause mortality at 1 year in a very old cohort of patients enrolled in our multidisciplinary Heart Failure Unit [HFU] after acute decompensated chronic HF.

Methods

The present study is a retro-prospective, single-center cohort analysis of very old HF patients enrolled from December 2016 to December 2018, and managed in our multidisciplinary HFU at Careggi University Hospital, Florence, Italy. Patients aged 85 years or more, referred to our HFU soon after acute decompensated HF composed our study cohort. Inclusion criteria were age equal or more than 85 years, confirmed diagnosis heart failure according to ESC guidelines criteria and a recent episode of acute decompensation with need to visit in Emergency Department and/or an hospitalization in Internal, Geriatric or Cardiology wards for signs or symptoms of acute HF [16]. Written informed consent release was collected by all patients and no exclusion criteria were pre-defined. Institutional Review Board approval was obtained [IRB approval: # CEAVC 14826, date 16.04.19].

Baseline clinical evaluation was carried out by cardiologists and geriatricians during the first on-site visit at our HFU. During this visit, age, weight, height, body mass index, medical history (including cardiovascular risk factors, and HF hospitalizations during the previous year), drug therapy, electrocardiogram, echocardiographic parameters, and laboratory data were recorded, together with information regarding educational level and social network. The renal function was evaluated with creatinine and estimated Glomerular Filtration Rate (e-GFR) calculated with Chronic Kidney Disease Epidemiology Collaboration [18] and was coded as severe when its value was < 30 ml/min/1.73m^2. Anemia was considered for hemoglobin < 12 g/dl in women and < 13 g/dl in men. During clinical evaluation, we assessed the presence of signs and symptoms of heart failure including New York Heart Association – NYHA – class, and signs of volume overload, such as jugular vein distension [JVD], hepatomegaly, ascites, peripheral edema and pulmonary congestion. Orthopnea, JVD and pedal edema were measured on a standardized 4-point scale ranging from 0 to 3 to calculate the composite congestion score of the EVEREST (Efficacy of Vasopressin Antagonism in Heart Failure Outcome Study with Tolvaptan) trial [19]. The EVEREST score has been validated in a cohort of patients hospitalized for acute HF and it has been demonstrated to be able to capture the changes in congestion during hospitalization and to be associated with a markedly increased risk of hospitalization for heart failure and all-cause mortality [19]. We calculated this score during

the first visit after discharge. All patients underwent a multi-dimensional comprehensive geriatric assessment performed by geriatricians, skilled nurses and physiotherapists at the entry visits with the aim of exploring the main emotional and physical function domains. Functional status was measured with BADL (Basic Activities of Daily Living) [20] and IADL (Instrumental Activities of Daily Living) [21]. Physical performance was measured with Short Physical Performance Battery (SPPB) [22] and screening for cognitive decline was evaluated with the mini-mental state examination (MMSE) [23]. Depressive symptoms were evaluated with 15-item Geriatric Depression Scale (GDS) [24].

All patients were evaluated by our HFU skilled nurse team regarding their level of disease awareness, self-management, and drug therapy adherence.

Based on first visit clinical results, a tailored follow-up program was planned assigning a color risk flag to each patient according to clinical severity to define the timing of the following visit; a follow-up visit after 30 ± 15 days, 3 ± 1 months and 6 ± 2 months was planned for patients coded as red, yellow and green respectively. The criteria for each flag risk profile have been detailed elsewhere and they were then used too for planning a tele-monitoring follow-up during COVID-19 first pandemic phase in Italy [25].

Statistical analysis

Statistical analysis was performed using SPSS® version 26.0 (SPSS, Inc., Chicago, IL, USA). Continuous variables are expressed as means ($\pm$ SD) and categorical variables as percentages, those variables without normal distribution as median (25th–75th inter-quartiles). Descriptive analyses were conducted. The associations between variables and the end point were tested using Student's t test for independent samples, chi-square test and Wilcoxon–Mann–Whitney test when appropriate. To identify independent predictors, variables with a significant association with the end point in bivariate analyses were entered into multivariable Cox regression model, with backward deletion (p out > 0.1) of redundant variables. Visual survival curves are represented with Kaplan–Meier analysis. Protection from type I error was set at an α level of 0.05.

Results

Study population characteristics

We enrolled 75 participants with a mean age 89.2 ± 2.8 years; 39 (52.0%) were females. Clinical, instrumental and bio-humoral characteristics are reported in Table 1. Analyzing geriatric domains in our cohort of patients, we observed that 20% lived alone, cognitive performance measured with

MMSE was 25.2 ± 5.0, BADL lost items were 1.6 ± 1.8 and IADL lost items were 3.7 ± 2.7, depressive symptoms measured with 15-item GDS was 5.3 ± 3.4; global physical performance at SPPB test was 6.3 ± 3.1. Our cohort was characterized by pharmacological complexity with a daily mean number of drugs of 8.7 ± 3.2.

Outcomes

Comparing HF hospitalization rates in the previous year with those of the year following the entry to our HFU, we observed a significant drop in hospital admissions: if 82.7% had at least one hospitalization for HF in the year previous of entry in our HFU program; this percentage declined to 30.6%; and this trend was observed also for those with 2 or more HF hospitalization, which declined from 38.7% to 26.1% (p < 0.001). Seventeen patients (22.7%) died during the 1-year follow-up (mean follow-up period 315 days). The trend in percentage and absolute all-cause mortality at 3, 6 and 12 months are reported in Fig. 1.

Pharmacological treatment

Analyzing Guidelines Directed Medical Treatments (GDMTs), we observed that 51 patients (68.0%) were in treatment with RAAS inhibitors (Ace/ARB), 60 (80%) with beta-blockers, 36 (48%) with mineralocorticoid antagonist, 2 patients (2.7%) with sacubitril/valsartan; both of them with starting dose; and none of them was treated with an SGLT2i, 71 (94.7%) patients received loop diuretics, none of them were in diuretic combination therapy.

Predictors of outcome

In Table 2, we report the clinical and bio-humoral differences between alive and dead patients at 1-year follow-up [univariate analysis]; patients who died during follow-up presented more often residual congestion as described by an EVEREST score > 4, elevated pulmonary artery pressure, different distribution of EF-based HF phenotype and lived more often alone. The result of multivariate Cox regression model is shown in Table 3; a higher level of EVEREST score and the status of living alone were found to be the two independent predictors of 1-year all-cause mortality in our HF population. In Fig. 2, the survival curves of study cohort are depicted, according to the EVEREST score for congestion severity (0–4 vs > 4) and the level of family support (living alone vs living with at least one family member).

Discussion

In this study, we report a faithful picture of everyday real world of octogenarians affected by HF: high rate of female gender, elevated prevalence of HFpEF phenotype, combined HF etiology, high burden of polypharmacy and presence of disability.

The main result of our study may be summarized as follows: in a cohort of octogenarians affected by HF, clinical relevant residual congestion after a recent episode of acute decompensated HF with contemporary presence of relative poor familial network [e.g., living alone] depicts an HF population with a high risk of mortality during 1-year follow-up.

We demonstrated in our octogenarians continuously managed in multidisciplinary HFU, that persistent congestion influences the long-term prognosis independently from ejection fraction phenotype, and HF etiology. Even recently, clinical data demonstrate that residual congestion at discharge rather than the timing of decongestion predicted a worse prognosis in patients with acute HF [26] and incomplete decongestion at discharge is one of the main causes of early re-hospitalization during 30-day follow-up after acute decompensated HF [27]. Thus, an accurate evaluation of sign of congestion is mandatory during the transition phase and different scores of congestion are elaborated for patients with HF and tested in different clinical settings [28] with the aim to intercept residual congestion; among these, one of most frequently used is the EVEREST score [13]. Statements invite clinicians to reach complete decongestion and euvolemic state before discharge patients admitted in hospital for acute HF and strongly recommend to organize a tailored continuum care program to avoid an early hospital reentry during the transition phase [29].

In addition, recent findings [30] underline how the fear of producing a renal hypoperfusion and consequent worsening renal function related to marked decongestion appears unjustified. In fact, marked decongestion when associated with an increase in hematocrit level is predictive of better prognosis in a patient with acute decompensated HF, independently from transient decrease in glomerular filtration rate.

In patients affected by cardiovascular disease, poor social relationship, unmarried status and living alone have already demonstrated to influence negatively clinical outcomes. In large FINAMI myocardial infarction register, single living and/or being unmarried showed to increase the risk of poor prognosis both in men and women after acute coronary syndrome, regardless of age [31] and interestingly, soon after

Table 1 Clinical characteristics of study population

	(n = 75)
Mean age (years)	89.2 ± 2.8
Female gender	39 (52.0)
Diabetes	17 (22.7)
Hypertension	70 (93.0)
History of coronary artery disease	28 (37.3)
Atrial fibrillation	50 (66.7)
Severe renal failure (e-GFR < 30 cc/min)	34 (45.3)
COPD	21 (28.0)
HF phenotype	
HFrEF	24 (32.0)
HFmrEF	18 (24.0)
HFpEF	33 (44.0)
NYHA	
I	4 (5.3)
II	26 (34.7)
III	42 (56.0)
IV	3 (4.0)
Aortic stenosis (moderate/severe)	17 (22.6)
Mitral regurgitation (moderate/severe)	52 (69.4)
Tricuspidal regurgitation (moderate/severe)	46 (61.4)
EVEREST score	5.1 ± 2.7
LVEF (%)	46.1 ± 12.1
TAPSE (mm)	18.2 ± 3.5
PAPs (mmhg)	41.2 ± 16.2
Hemoglobin (gr/dl)	12.1 ± 1.6
Sodium (meq/l)	139.1 ± 3.4
Potassium (meq/l)	4.2 ± 0.6
Creatinine (mg/dl)	1.3 ± 0.4
NT-proBNP (pg/ml)[a]	3905.0 (2054.8–9900.0)
BADL (lost)[b]	1 (0–6)
IADL (lost)[b]	3 (0–8)
GDS (score)	5.3 ± 3.4
MMSE (score)	25.2 ± 5.0
SPPB (score)	6.3 ± 3.1
Living alone	15 (20.0)
Drug therapies (n)	8.7 ± 3.2
Hospit. for ADHF previous year ≥ 1	62 (82.7)

HF heart failure, *HFrEF* HF with reduced ejection fraction, *HFmrEF* HF with mid-range ejection fraction, *HFpEF* HF with preserved ejection fraction, *COPD* chronic obstructive pulmonary disease, *NYHA* New York Heart Association, *LVEF* left ventricular ejection fraction, *TAPSE* tricuspid annular plane systolic excursion, *e-GFR* estimated glomerular filtration rate according to CKD-EPI formula, *ADHF* acute decompensated HF, *SPPB* short physical performance battery, *PAPs* systolic pulmonary artery pressure, *BADL* basic activities of daily living, *IADL* instrumental activities of daily living, *GDS* geriatric depression scale, *MMSE* mini-mental state examination

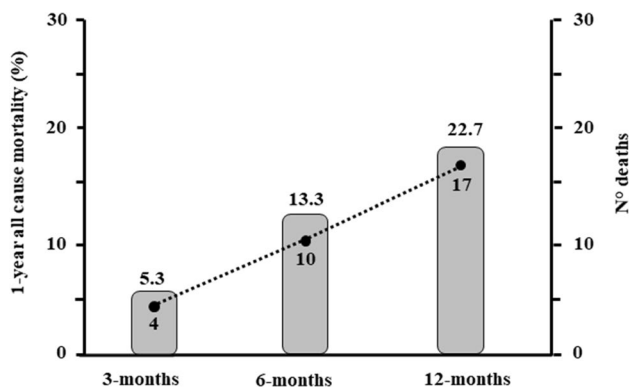[a]Median (25th–75th percentiles)

[b]Median (min–max)

Fig. 1 Trend at 3, 6 and 12 months of absolute and rate of all-cause mortality in study population

ACS, incident events were higher in unmarried respect married subjects.

In the field of HF, data from Sudden Cardiac Death in Heart Failure Trial [SCD-HeFT] [32] demonstrated that 24-month all-cause mortality was 8% among patients with high social support and without depression or anxiety, 16% for socially isolated patients with anxiety or depression, and 20% for socially isolated patients with anxiety and depression. In this study, the presence of social isolation increased the independent risk of all-cause death as showed by a HR = 1.75 [32]. Similarly for the 90-day hospitalization rate, social isolation was one of the strongest predictors among 148 very-old patients with HF [80 ± 8 years] [31]; HF re-hospitalization occurred within 90 days for 25 patients, and

Table 2 Bivariate predictors of the primary end point (1-year all-cause mortality)

Clinical characteristics	Alive (n = 58)	Died (n = 17)	p value
Mean age (years)	90.0 ± 2.7	89.9 ± 3.0	0.242
Female gender	53.4	47.1	0.643
Diabetes	24.1	17.5	0.574
Hypertension	91.4	100.0	0.210
History of coronary artery disease	34.5	47.1	0.346
Atrial fibrillation			
Severe renal failure (e-GFR < 30 cc/min)	43.1	52.9	0.649
COPD			
HF phenotype			
HFrEF	36.2	17.9	0.006
HFmrEF	15.5	52.9	
HFpEF	48.3	29.4	
NYHA			
I	5.2	5.9	0.731
II	37.9	23.5	
III	53.4	64.7	
IV	3.4	5.9	
EVEREST score	4.7 ± 2.5	6.6 ± 3.0	0.011
LVEF (%)	46.5 ± 12.6	44.7 ± 10.9	0.581
TAPSE (mm)	18.6 ± 3.5	16.8 ± 3.5	0.073
PAPs (mmhg)	38.4 ± 15.5	51.0 ± 15.1	0.005
Hemoglobin (g/dl)	11.9 ± 1.4	11.6 ± 1.6	0.407
Sodium (g/dl)	139.4 ± 3.2	137.8 ± 3.9	0.079
Potassium (g/dl)	4.2 ± 0.5	4.3 ± 0.8	0.723
Creatinine (g/dl)	1.3 ± 0.4	1.3 ± 0.5	0.801
NT-proBNP (pg/ml)[a]	3218 (1926.6–10,369.5)	6236.0 (4608.5–8861.0)	0.133
BADL (lost)	1.5 ± 1.6	2.1 ± 2.2	0.290
IADL (lost)	3.6 ± 2.7	3.6 ± 3.1	0.937
GDS (score)	5.5 ± 3.3	4.3 ± 3.7	0.322
MMSE (score)	25.3 ± 4.7	24.6 ± 6.2	0.692
SPPB (score)	6.1 ± 3.1	7.5 ± 3.1	0.322
Living alone	15.5	37.5	0.051
Drug therapies (n)	9.0 ± 3.4	7.6 ± 2.1	0.105
Hospit. for ADHF previous year ≥ 1	82.4	82.8	0.969

[a]Median (25th–75th percentiles)

Abbreviations as in Table 1

Table 3 Multivariable prediction of 1-year all-cause mortality (Cox regression model with backward deletion of redundant variables)

	HR (95% CI)	*p* value
Age	–	0.878
Gender	–	0.257
EVEREST score > 4	1.24 (1.04–1.47)	0.014
Living alone	3.34 (1.16–9.64)	0.026
HF type	–	0.460
PAPs	–	0.224

Abbreviations as in Table 1

the rate was significantly higher in the social isolation group [p = 0.036] with a LASSO coefficient in the Cox regression model set to 0.58 [33]. The negative effect of social isolation on outcomes in HF patients seems to be more pronounced in men than in women; in a cohort of 581 patients, during 3-year follow-up, Takabayashi et al. [34] reported a clear gender difference regarding the risk of re-hospitalization after discharge from acute HF episode with a HR = 2.02 for male, but not for women patients living alone. Obviously, living alone can exacerbate and aggravate a pre-existing state of disability, which, as reported by the RICA study [17], has been already demonstrated to be an independent predictor of prognosis in very old patient with chronic HF.

Independently from real level of social and family interactions, also patient's perceived social isolation is associated with an increased risk of death and healthcare use. Data from study conducted in Southeast Minnesota [35] showed that patients who reported high-perceived social isolation had > 3.5 times increased risk of death and, compared to patients who self-reported low-perceived social isolation, patients reporting moderate-perceived social isolation had a 16% increased risk of outpatient visits, whereas those reporting high-perceived social isolation had a 26% increased risk.

We can speculate about pathophysiological mechanisms, underlining the increased risk of mortality/morbidity associated with living alone. Undoubtedly, social isolation is associated with loneliness and depressive symptoms and interconnected psychosocial mechanisms could explain the negative influence on recommended drug therapy adherence [36] particularly evident in older patients affected by chronic diseases [37].

Experimental data demonstrated how social isolation directly or mediated by depressive symptoms is able to produce an autonomic imbalance characterized by exaggerated sympathetic up-regulation and reduced parasympathetic tone [38], both alterations particularly detrimental in HF patients [39]. In addition, trait sensitivity to social isolation enhances pro-inflammatory responses in plasma, as well as up-regulation of genes related to inflammation, including TNF-α and IL-6 ones; both cytokines demonstrated to mark negatively overall prognosis in HF [40].

Study limitations

The main limitations of the study are the relative small number of very old participants even if their elevated mean age and features well represent the real-world clinical practice in the field of HF; the study has all limits of an observational cohort protocol and the small number of events limited our
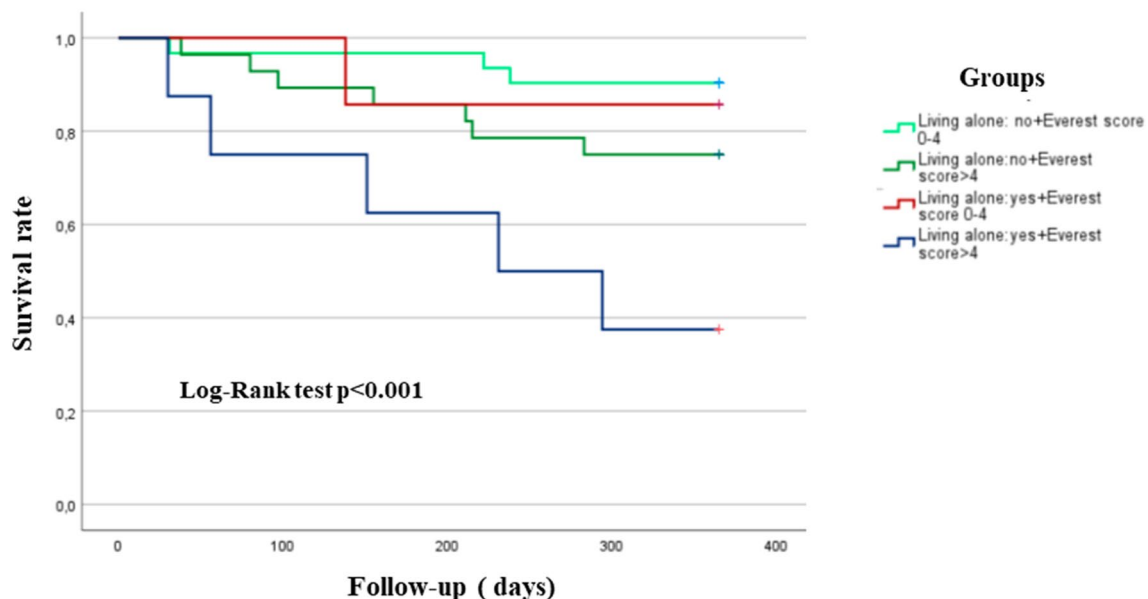

Fig. 2 Kaplan–Meier curves in the four groups according to EVEREST score and living alone

analysis to all-cause mortality without the possibility to analyze those related to cardiovascular reasons.

In conclusion, in our very old study population affected by chronic HF, the contemporary presence of high level of residual congestion with social isolation such as living alone identifies subject with elevated risk of death at 1-year follow-up after recent HF hospitalization.

In our opinion for an optimal continuum health care management of older patients with HF, these evidences reinforce the need for transitional care programs, aimed to intercept residual pulmonary or systemic congestion soon after hospital discharge and encourage an implementation of geriatric domain evaluations and consequent interventions to reduce the negative effect of poor social network relationships or social isolation associated with living alone. These data suggest that in very old patients with chronic heart failure, a multidisciplinary approach that comprises not only clinical evaluations, but also social, functional, cognitive and emotional aspects, may allow a better risk stratification by capturing more accurately all prognostic predictors.

Declarations

Ethical approval The study is conform to ethical standard according to Declaration of Helsinky.

Informed consent Written informed consent release was collected by all patients. Institutional Review Board approval was obtained [IRB approval: # CEAVC 14826, date 16.04.19].

References

1. Mosterd A, Hoes AW (2007) Clinical epidemiology of heart failure. Heart 93:1137–1146

2. Ceia F et al (2002) Prevalence of chronic heart failure in Southwestern Europe: the EPICA study. Eur J Heart Fail 4:531–539

3. Shafazand M, Schaufelberger M, Lappas G, Swedberg K, Rosengren A (2009) Survival trends in men and women with heart failure of ischaemic and non-ischaemic origin: data for the period 1987–2003 from the Swedish Hospital Discharge Registry. Eur Heart J 30(6):671–678

4. Owan TE, Hodge DO, Herges RM et al (2006) Trends in prevalence and outcome of heart failure with preserved ejection fraction. N Engl J Med 355(3):251–259

5. Meta-analysis Global Group in Chronic Heart Failure [MAGGIC] (2012) The survival of patients with heart failure with preserved or reduced left ventricular ejection fraction: an individual patient data meta-analysis. Eur Heart J 33:1750–1757

6. Gheorghiade M, Vaduganathan M, Fonarow GC, Bonow RO (2013) Rehospitalization for heart failure: problems and perspectives. J Am Coll Cardiol 61(4):391–403

7. O'Connor CM, Abraham WT, Albert NM et al (2008) Predictors of mortality after discharge in patients hospitalized with heart failure: an analysis from the Organized Program to Initiate Lifesaving Treatment in Hospitalized Patients with Heart Failure [OPTIMIZE-HF]. Am Heart J 156(4):662–673

8. Sunaga A, Hikoso S, Yamada T, Yasumura Y et al (2021) Prognostic impact of Clinical Frailty Scale in patients with heart failure with preserved ejection fraction. ESC Heart Fail 8(4):3316–3326

9. Vidán MT, Martín Sánchez FJ, Sánchez E et al (2019) Most elderly patients hospitalized for heart failure lack the abilities needed to perform the tasks required for self-care: impact on outcomes. Eur J Heart Fail 21(11):1434–1442

10. Gheorghiade M, Vaduganathan M, Fonarow GC, Bonow RO (2013) Re-hospitalization for heart failure: problems and perspectives. J Am Coll Cardiol 61(4):391–403

11. Desai AS, Stevenson LW (2012) Rehospitalization for heart failure: predict or prevent? Circulation 126(4):501–506

12. Hollenberg SM, Warner Stevenson L, Ahmad T et al (2019) For 2019 ACC expert consensus decision pathway on risk assessment, management, and clinical trajectory of patients hospitalized with heart failure: a report of the American College of Cardiology Solution Set Oversight Committee. J Am Coll Cardiol 74(15):1966–2011

13. McDonagh TA, Metra M, Adamo M, Gardner RS, Baumbach A, Böhm M, Burri H, Butler J, Čelutkienė J, Chioncel O, Cleland JGF, Coats AJS, Crespo-Leiro MG, Farmakis D, Gilard M, Heymans S, Hoes AW, Jaarsma T, Jankowska EA, Lainscak M, Lam CSP, Lyon AR, McMurray JJV, Mebazaa A, Mindham R, Muneretto C, Francesco Piepoli M, Price S, Rosano GMC, Ruschitzka F, Kathrine SA, ESC Scientific Document Group (2021) 2021 ESC guidelines for the diagnosis and treatment of acute and chronic heart failure. Eur Heart J 42(36):3599–3726

14. Ambrosy AP et al (2013) Clinical course and predictive value of congestion during hospitalization in patients admitted for worsening signs and symptoms of heart failure with reduced ejection fraction: findings from the EVEREST trial. Eur Heart J 34:835–843

15. Feltner C, Jones CD, Cené CW et al (2014) Transitional care interventions to prevent readmissions for persons with heart failure: a systematic review and meta-analysis. Ann Intern Med 160(11):774–784

16. Van Spall HGC, Rahman T, Mytton O et al (2017) Comparative effectiveness of transitional care services in patients discharged from the hospital with heart failure: a systematic review and network meta-analysis. Eur J Heart Fail 19(11):1427–1443

17. Huerta-Preciado J, Franco J, Formiga F, Iborra PL, Epelde F, Franco ÁG, Ormaechea G, Manzano L, Cepeda-Rodrigo JM, Montero-Pérez-Barquero M, With the Aid of RICA Investigators Group (2020) Differential characteristics of acute heart failure in

very elderly patients: the prospective RICA study. Aging Clin Exp Res 32(9):1789–1799

18. Fernandez-Prado R, Castillo-Rodriguez E, Velez-Arribas FJ, Gracia-Iguacel C, Ortiz A (2016) Creatinine clearance is not equal to glomerular filtration rate and Cockcroft–Gault equation is not equal to CKD-EPI collaboration equation. Am J Med 129(12):1259–1263

19. Ambrosy AP, Pang PS, Khan S, Konstam MA, Fonarow GC, Traver B, Maggioni AP, Cook T, Swedberg K, Burnett JC Jr, Grinfeld L, Udelson JE, Zannad F, Gheorghiade M, EVEREST Trial Investigators (2013) Clinical course and predictive value of congestion during hospitalization in patients admitted for worsening signs and symptoms of heart failure with reduced ejection fraction: findings from the EVEREST trial. Eur Heart J 34(11):835–843

20. Katz S, Ford AB, Moskowitz RW et al (1963) Studies of illness in the aged. The Index of ADL: a standardized measure of biological and psychosocial function. JAMA 185:914–919

21. Lawton MP, Brody EM (1969) Self-maintaining and instrumental activities of daily living. Gerontologist 9:179–186

22. Guralnik JM, Ferrucci L, Simonsick E et al (1995) Lower-extremity function in persons over the age of 70 years as a predictor of subsequent disability. N Engl J Med 332:556–561

23. Magni E, Binetti G, Bianchetti A, Rozzini R, Trabucchi M (1996) Mini-Mental State Examination: a normative study in Italian elderly population. Eur J Neurol 3(3):198–202

24. Sheikh JI, Yesavage JA (1986) Geriatric Depression Scale (GDS): recent evidence and development of a shorter version. Clin Gerontol 5:165–173

25. Orso F, Herbst A, Migliorini M, Ghiara C, Virciglio S, Camartini V, Tognelli S, Lucarelli G, Fortini G, Pratesi A, Di Bari M, Marchionni N, Ungar A, Fattirolli F, Baldasseroni S (2022) Telehealth management and risk stratification of older patients with chronic heart failure during COVID-19 pandemic: prognostic evaluation of the TeleHFCovid19-Score. J Am Med Dir Assoc 23(3):421–427

26. Horiuchi Y, Wettersten N, van Veldhuisen DJ, Mueller C, Filippatos G, Nowak R, Hogan C, Kontos MC, Cannon CM, Müeller GA, Birkhahn R, Taub P, Vilke GM, Barnett O, McDonald K, Mahon N, Nuñez J, Briguori C, Passino C, Maisel A, Murray PT (2021) Relation of decongestion and time to diuretics to biomarker changes and outcomes in acute heart failure. Am J Cardiol 15:70–79

27. Kristjánsdóttir I, Thorvaldsen T, Lund LH (2020) Congestion and diuretic resistance in acute or worsening heart failure. Card Fail Rev 28(6):e25

28. Girerd N, Seronde MF, Coiro S, Chouihed T, Bilbault P, Braun F, Kenizou D, Maillier B, Nazeyrollas P, Roul G, Fillieux L, Abraham WT, Januzzi J Jr, Sebbag L, Zannad F, Mebazaa A, Rossignol P, INI-CRCT, Great Network, and the EF-HF Group (2018) Integrative assessment of congestion in heart failure throughout the patient journey. JACC Heart Fail. 6(4):273–285

29. Hollenberg SM, Warner Stevenson L, Ahmad T, Amin VJ, Bozkurt B, Butler J, Davis LL, Drazner MH, Kirkpatrick JN, Peterson PN, Reed BN, Roy CL, Storrow AB (2019) 2019 ACC expert consensus decision pathway on risk assessment, management, and clinical trajectory of patients hospitalized with heart failure: a report of the American College of Cardiology Solution Set Oversight Committee. J Am Coll Cardiol 74(15):1966–2011

30. McCallum W, Tighiouart H, Testani JM, Griffin M, Konstam MA, Udelson JE, Sarnak MJ (2020) Acute kidney function declines in the context of decongestion in acute decompensated heart failure. JACC Heart Fail 8(7):537–547

31. Lammintausta A, Airaksinen JK, Immonen-Räihä P, Torppa J, Kesäniemi AY, Ketonen M, Koukkunen H, Kärjä-Koskenkari P, Lehto S, Salomaa V, FINAMI Study Group (2014) Prognosis of acute coronary events is worse in patients living alone: the FINAMI myocardial infarction register. Eur J Prev Cardiol 21(8):989–996

32. Friedmann E, Thomas SA, Liu F, Morton PG, Chapa D, Gottlieb SS, Sudden Cardiac Death in Heart Failure Trial Investigators (2006) Relationship of depression, anxiety, and social isolation to chronic heart failure outpatient mortality. Am Heart J 152(5):940.e1–8

33. Saito H, Kagiyama N, Nagano N, Matsumoto K, Yoshioka K, Endo Y, Hayashida A, Matsue Y (2019) Social isolation is associated with 90-day rehospitalization due to heart failure. Eur J Cardiovasc Nurs 18(1):16–20

34. Takabayashi K, Kitaguchi S, Iwatsu K, Ikeda T, Fujita R, Okuda M, Nakajima O, Koito H, Terasaki Y, Kitamura T, Nohara R (2020) Living alone and gender differences in rehospitalization for heart failure after discharge among acute heart failure patients. Int Heart J 61(6):1245–1252

35. Manemann SM, Chamberlain AM, Roger VL, Griffin JM, Boyd CM, Cudjoe TKM, Jensen D, Weston SA, Fabbri M, Jiang R, FinneyRutten LJ (2018) Perceived social isolation and outcomes in patients with heart failure. J Am Heart Assoc 7(11):e008069

36. Lu J, Zhang N, Mao D, Wang Y, Wang X (2020) How social isolation and loneliness effect medication adherence among elderly with chronic diseases: an integrated theory and validated cross-sectional study. Arch Gerontol Geriatr 90:104154

37. Anderson RT, Ory M, Cohen S, McBride JS (2000) Issues of aging and adherence to health interventions. Control Clin Trials 21(5 Suppl):171S-S183

38. Grippo AJ, Lamb DG, Carter CS, Porges SW (2007) Social isolation disrupts autonomic regulation of the heart and influences negative affective behaviors. Biol Psychiatry 62(10):1162–70

39. Rundquist B, Elam M, Bergmann-Sverrisdottir Y, Eisenhoffer G, Friberg P (1997) Increased cardiac adrenergic drive precedes generalized sympathetic activation in human heart failure. Circulation 95:169–175

40. Moieni M, Irwin MR, Jevtic I, Breen EC, Cho HJ, Arevalo JM, Ma J, Cole SW, Eisenberger NI (2015) Trait sensitivity to social disconnection enhances pro-inflammatory responses to a randomized controlled trial of endotoxin. Psychoneuroendocrinology 62:336–342