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SHORT COMMUNICATION

Usefulness of a personalized algorithm-based discharge checklist in patients hospitalized for acute heart failure

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Abstract

Aims The aim of this study is to evaluate the usefulness of a personalized discharge checklist (PCL) based on simple baseline characteristics on mortality, readmission for heart failure (HF), and quality of care in patients hospitalized for acute HF.

Methods and results We designed an algorithm to generate PCL, based on 2016 HF European Society of Cardiology Guidelines and the screening of common comorbidities in elderly HF patients. We prospectively included 139 patients hospitalized for HF from May 2018 to October 2018. A PCL was fulfilled for each patient at admission and 24 to 48 hours before the planned discharge. A control cohort of 182 consecutive patients was retrospectively included from May 2017 to October 2017. The primary composite endpoint was mortality or readmission for HF at 6 months. The secondary endpoints were mortality, readmission for HF, and quality of care (evidence-based medications, management of HF comorbidities, and planned care plan). There was no difference among baseline characteristics between PCL and control cohorts; mean age was 78.1 ± 12.2 vs. 79.0 ± 12.5 years old (P = 0.46) and 61 patients (43.9%) vs. 63 (34.6%) had HF with left ventricular ejection fraction (LVEF) $<$40% (P = 0.24). During the 6 month follow-up period, 59 patients (42.4%) reached the primary endpoint in the PCL cohort vs. 92 patients (50.5%) in the control cohort [hazard ratio (HR): 0.79, 95% confidence interval (CI) (0.57–1.09), P = 0.15]. Subgroup analysis including only patients with either altered ($<$40%) or mid-range or preserved ($\geq$40%) LVEF showed no significant difference among groups. There was a non-significant trend toward a reduction in HF readmission rate in the PCL group [38 patients (27.3%) vs. 64 patients (35.2%), HR: 0.73, 95%CI (0.49–1.09), P = 0.13]. There was no difference regarding survival or the use of evidence-based medications. A higher proportion of patients were screened and treated for iron and vitamin D deficiencies (53.2% vs. 35.7%, $P < 0.01$ and 73.4% vs. 29.7%, $P < 0.01$, respectively), as well as malnutrition supplemented in the PCL group. There was a higher referral to HF follow-up programme in the PCL group but not to telemedicine or cardiac rehabilitation programs.

Conclusions In this preliminary study, the use of a PCL did not improve outcomes at 6 months in patients hospitalized for acute HF. There was a non-significant trend towards a reduction in HF readmission rate in the PCL group. In addition, the management of HF comorbidities was significantly improved by PCL with a better referral to follow-up programme. A multicentre study is warranted to assess the usefulness of a simple costless personalized checklist in a large HF patients' population.

Keywords Discharge checklist; Heart failure

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Introduction

Background

After discharge, readmission is common in patients with heart failure (HF), with a rate ranging from 15% at 30 days[1,2] to 50% at 6 months,[3] and is associated with significant medico-economic impact and poor prognosis. Most of the readmissions occurring in the post-discharge period could be avoided.[4] The use of a discharge checklist yielded a better up-titration of evidence-based medications, a higher referral to telemedicine and a higher proportion of patients with planned medical appointments at discharge.[5] However, a single discharge checklist may not have the same usefulness in the broad spectrum of patients with HF.

Aims

We designed an automated personalized discharge checklist (PCL) to help physicians in treatment optimization and planning care plan at discharge. The aim of this study was to evaluate the usefulness of this checklist in improving quality of care and in reducing rehospitalization and mortality rates in this population.

Methods

Checklist

We designed an algorithm to generate PCL for each patient based on HF European Society of Cardiology Guidelines,[6] *Figure 1*. We computed three parameters [age, left ventricular ejection fraction (LVEF), and history of HF], and the algorithm adds or removes specific queries depending on the provided data. Corrective action is suggested if one given point is not optimized yet. Malnutrition and vitamin D deficiency are common comorbidities in elderly HF patients[7] and were added to the algorithm.

Patient population

We sought to prospectively include all HF patients hospitalized from May 2018 to October 2018 in our HF unit. Patients were included if they were discharged at home or in a cardiac rehabilitation centre, whatever the LVEF. Exclusion criteria included transfer to a noncapable cardiac rehabilitation hospitalization unit. PCL was fulfilled at admission and 24–48 h before the planned discharge in order to allow therapeutic optimization and follow-up planning (estimated time spent: 5–10 min twice). A PCL was retrospectively fulfilled using the latest available data at the time of discharge in a control cohort (from May 2017 to October 2017). General practitioners and referring cardiologists were contacted for follow-up data.

Endpoints and definitions

The primary endpoint was composite criteria of mortality or readmission for HF within 6 months of discharge. Secondary endpoints were defined as mortality, readmission for HF, and quality of care rendered as measured by evidence-based medications, appropriate medication up-titration, correction of deficiencies, and planned care plan. Iron deficiency was defined as usual.[8]

Statistical analysis

Quantitative variables were described as mean ± standard deviation and compared using Student's *t*-test. Qualitative variables were described as number and percentage and were compared using Fisher's exact test. Differences between groups in the rate of occurrence of endpoints were tested using Cox proportional hazards regression. A *P* value <0.05 was considered significant.

Results

Among the 189 patients hospitalized for acute HF during the inclusion period of the prospective cohort, 22 were excluded, and the PCL was not fulfilled in 27 patients. We retrospectively included 183 patients in the control cohort. Baseline characteristics are depicted in *Table 1*, and checklist data are depicted in *Table 2*. There were less patients with a significant worsening in kidney function during hospitalization in the PCL group. Natriuretic peptides measurements were available in 128 patients (92.1%) in the PCL group vs. 150 patients (82.4%) in the control group ($P = 0.02$) without significant difference among natriuretic peptides levels when available. The primary endpoint (composite criteria of mortality or readmission for HF within 6 months of discharge) occurred in 59 patients (42.4%) in the PCL group vs. 92 patients (50.5%) in the control group [hazard ratio: 0.79, 95% confidence interval (0.57–1.09), $P = 0.15$, *Figure 2* and *Table 3*]. There was no difference either among groups in the subgroup analysis according to LVEF. Regarding secondary endpoints, there was no difference regarding survival among groups. There was a non-significant trend toward a reduction in HF readmission rate in the PCL group [38 patients (27.3%) vs. 64 patients (35.2%), hazard ratio: 0.73, 95% confidence interval (0.49–1.09), $P = 0.13$]. The screening for iron deficiency was better performed in the PCL group, leading to a higher proportion of patients treated with iron (either per os or

Figure 1 Two examples of personalized discharge checklist. Upper panel: a 42-year-old man with de novo heart failure, LVEF = 25%. This is the algorithm-generated checklist at admission. Lower panel: a 82-year-old man with hypertension, hospitalized for a new episode of decompensated heart failure secondary to pneumonia. No coronary artery disease. LVEF = 60%. This is the checklist 48 h before discharge. According to cardiologist's inputs, the checklist automatically changes and advises to consider the inclusion in a follow-up programme, cardioversion, anticoagulation, work-flow of anaemia, and the correction of the identified precipitating factor (infection). Note that evidence-based medications are different from the checklist of the younger patient. ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin II receptor blocker; ARNI, angiotensin-receptor neprilysin inhibitor; BNP, brain natriuretic peptide; ECG, electrocardiogram; HF, heart failure; LVEF, left ventricular ejection fraction; MRA, mineralo-receptor antagonist; MRI, magnetic resonance imaging; PCL, personalized discharge checklist; PRADO, programme d'accompagnement au retour à domicile; SCAD, suivi clinique à domicile; TSAT, transferrin saturation; TSH, thyroid-stimulating hormone.

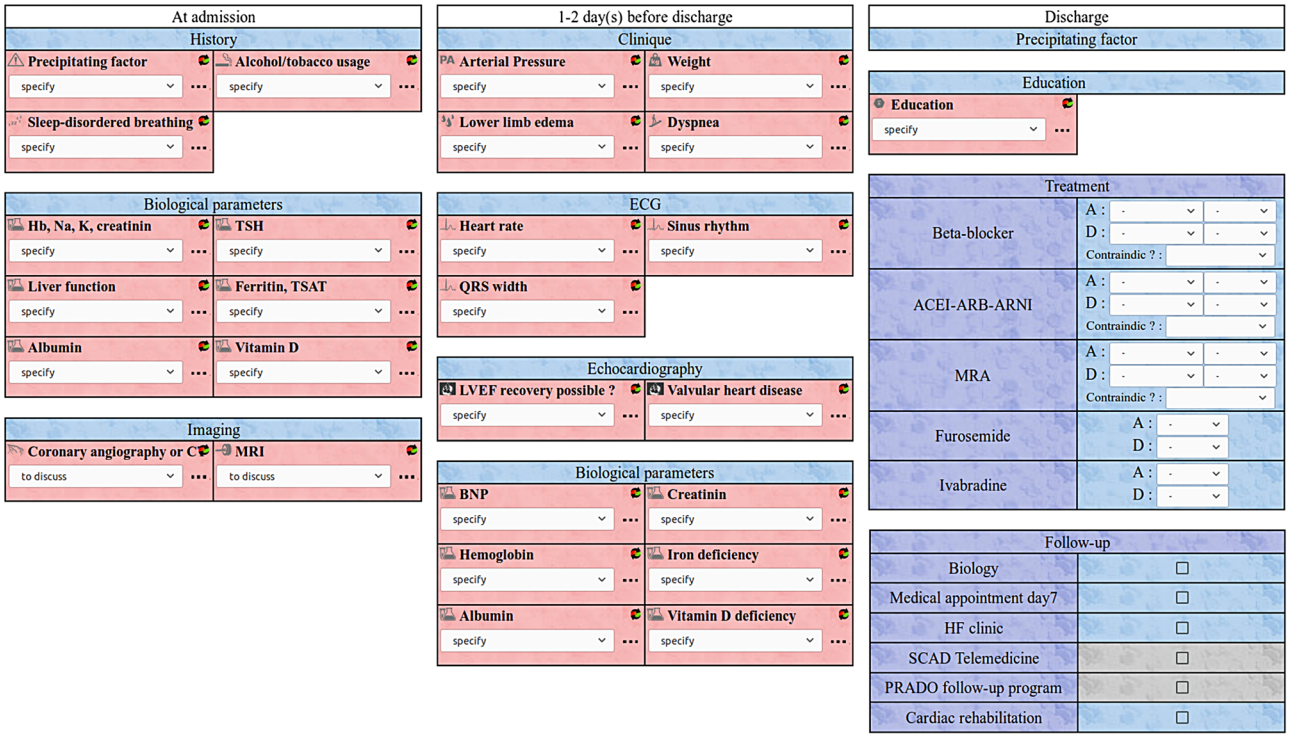

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Table 1 Baseline characteristics

Characteristic	PCL cohort (n = 139)	Control cohort (n = 182)	P value
Age, years	78.1 ± 12.2	79.0 ± 12.5	0.46
Sex, male	81 (58.3%)	90 (49.5%)	0.15
History of HF			0.19
De novo	35 (25.2%)	52 (28.6%)	
Ischaemic cardiomyopathy	58 (41.7%)	58 (31.9%)	
Non-ischaemic cardiomyopathy	46 (33.1%)	72 (39.6%)	
Hospitalization for HF in the last year	48 (34.5%)	54 (29.7%)	0.40
Trigger factor (chronic HF patients)	(n = 104)	(n = 130)	0.31
Salt intake	15 (14.4%)	33 (25.4%)	
Infection	18 (17.3%)	29 (22.3%)	
Atrial fibrillation or atrial flutter	13 (12.5%)	15 (11.5%)	
Hypertension	11 (10.6%)	12 (9.2%)	
Iatrogenic	7 (6.7%)	7 (5.4%)	
Myocardial ischaemia	5 (4.8%)	4 (3.1%)	
Unknown or other	35 (33.7%)	30 (23.1%)	
LVEF (%)	41.3 ± 14.8	43.5 ± 13.0	0.18
LVEF <40%	61 (43.9%)	63 (34.6%)	0.24
LVEF 40–49%	24 (17.3%)	35 (19.2%)	
LVEF ≥50%	54 (38.8%)	84 (46.2%)	

HF, heart failure; LVEF, left ventricular ejection fraction; PCL, personalized discharge checklist.
Data were expressed as mean ± standard deviation or n (%).

Table 2 Checklist data at discharge

Checklist	PCL cohort (n = 139)	Control cohort (n = 182)	P value
Target systolic BP	133 (95.7%)	180 (98.9%)	0.09
Target HR	107 (77.0%)	142 (78.0%)	0.28
Correction of a triggering factor[a]	66 (82.5%)	101 (84.9%)	0.81
Rhythm			
Sinus rhythm	71 (51.1%)	93 (51.1%)	0.77
Paroxysmal or persistent atrial fibrillation	26 (18.7%)	29 (15.9%)	
Permanent atrial fibrillation	42 (30.2%)	30 (33.0%)	
Brain natriuretic peptide[b]			
<350 ng/mL	50 (39.1%)	71 (47.3%)	0.19[d]
350–700 ng/mL	36 (28.1%)	44 (29.3%)	
≥700 ng/mL	42 (32.8%)	35 (23.3%)	
None available	11 (7.9%)	32 (17.6%)	
Creatinine, stable or increase <20%	123 (88.5%)	143 (78.6%)	0.03
Haemoglobin[b]			
<10 g/dL	25 (18.0%)	21 (11.5%)	0.26
10–12 g/dL	37 (26.6%)	55 (30.2%)	
≥12 g/dL	77 (55.4%)	106 (58.2%)	
Iron deficiency			
Ferritin and total saturation of transferrin available	137 (98.6%)	123 (67.6%)	<0.001
No iron deficiency	51 (36.7%)	44 (24.2%)	
Iron deficiency, treated with per os iron	32 (23.0%)	21 (11.5%)	
Iron deficiency, treated with intravenous iron	42 (30.2%)	44 (24.2%)	
Iron deficiency, not treated	12 (8.6%)	14 (7.7%)	
Albumin			
Available	139 (100.0%)	167 (91.8%)	0.001
Albumin ≥35 g/L at discharge	91 (67.4%)	122 (73.1%)	0.35
Oral nutritional supplement at discharge	41 (29.5%)	18 (9.9%)	<0.001
Vitamin D			
Available	135 (97.1%)	82 (45.1%)	<0.001
Correction of vitamin D deficiency	102 (73.4%)	54 (29.7%)	<0.001
Treatments[b]			
Patients with a HF indication and without contraindication[e] for β-blockers	44 (31.7%)	54 (29.7%)	0.80
Dose at admission (% of the recommended dose)	19.6% ± 24.8%	19.4% ± 26.8%	0.98
Dose at discharge (% of the recommended dose)	29.3% ± 17.0%	34.3% ± 23.4%	0.24
No β-blockers at discharge	0	1 (1.9%)	0.81
Dose decreased at discharge	5 (11.4%)	5 (9.3%)	
No dose change at discharge	12 (27.3%)	16 (29.6%)	
Dose increased at discharge	27 (61.4%)	32 (59.3%)	

(*Continues*)

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Table 2 (continued)

Checklist	PCL cohort (n = 139)	Control cohort (n = 182)	P value
Patients with a HF indication for ACEI/ARB/ARNI	53 (38.1%)	61 (33.5%)	0.46
Dose at admission (% of the recommended dose)	20.3% ± 34.5%	25.8% ± 34.8%	0.40
Dose at discharge (% of the recommended dose)	21.7% ± 19.8%	30.7% ± 30.2%	0.07
No ACEI/ARB/ARNI at discharge	9 (17.0%)	12 (19.7%)	0.41
Dose decreased at discharge	9 (17.0%)	8 (13.1%)	
No dose change at discharge	7 (13.2%)	15 (24.6%)	
Dose increased at discharge	28 (52.8%)	26 (42.6%)	
Patients treated with a MRA at discharge	17 (13.0%)	20 (11.0%)	0.73
Diuretics			
Dose of furosemide at admission (mg)	61 ± 77	47 ± 71	0.09
Dose of furosemide at discharge (mg)	83 ± 82	69 ± 72	0.12
No furosemide at discharge	14 (10.2%)	19 (10.5%)	0.32
Dose of furosemide decreased at discharge	17 (12.4%)	12 (6.6%)	
No dose change of furosemide at discharge	26 (19.0%)	42 (23.2%)	
Dose of furosemide increased at discharge	80 (58.4%)	108 (59.7%)	
Planned follow-up[c]	72 (51.8%)	65 (35.7%)	0.006
PRADO follow-up programme	39 (28.1%)	21 (11.5%)	<0.001
Telemedicine/SCAD programme	13 (9.4%)	22 (12.1%)	0.55
Cardiac rehabilitation	27 (19.4%)	23 (12.6%)	0.14

ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin II receptor blocker; ARNI, angiotensin-receptor neprilysin inhibitor; BP, blood pressure; HF, heart failure; HR, heart rate; MRA, mineralo-receptor antagonist; PCL, personalized discharge checklist; PRADO, programme d'accompagnement au retour à domicile; SCAD, suivi clinique à domicile.
Data were expressed as n (%) or mean ± standard deviation as appropriate.
[a]Only patients with an identified triggering factor during hospitalization.
[b]Percentages may not add up to 100% due to rounding
[c]A patient could be included in more than one follow-up programme.
[d]Only patients with brain natriuretic peptide level available were compared.
[e]Contraindications include significant right ventricular dysfunction, restrictive cardiomyopathy, cardiac amyloidosis, and severe aortic stenosis.

Figure 2 Survival freedom from hospitalization for heart failure (HF).

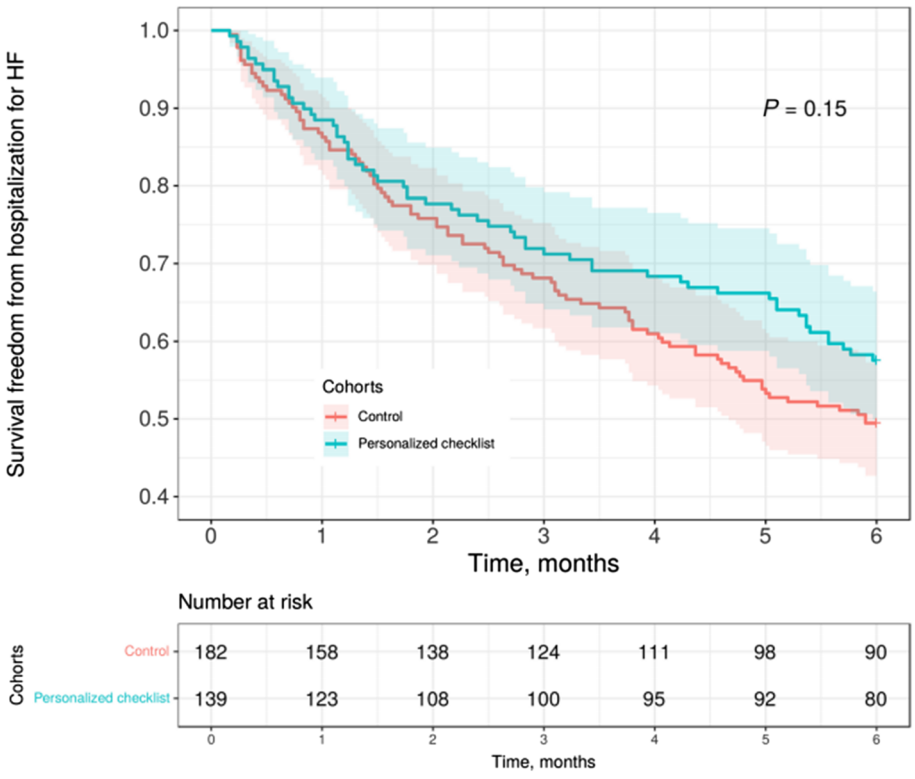

Table 3 Outcomes at 6 months

Endpoint	PCL cohort (n = 139)	Control cohort (n = 182)	Hazard ratio (HR) [95%CI]	P value
Primary composite endpoint (mortality or readmission for HF)				
Overall	59 (42.4%)	92 (50.5%)	0.79 [0.57–1.09]	0.15
LVEF <40%	26 (42.6%) (n = 61)	29 (46.0%) (n = 63)	0.90 [0.53–1.54]	0.71
LVEF ≥40%	33 (42.3%) (n = 78)	63 (52.9%) (n = 119)	0.73 [0.48–1.11]	0.14
Secondary endpoints				
All-cause death	32 (23.0%)	42 (23.1%)	0.99 [0.62–1.56]	0.95
Readmission for HF	38 (27.3%)	64 (35.2%)	0.73 [0.49–1.09]	0.13

HF, heart failure; LVEF, left ventricular ejection fraction; PCL, personalized discharge checklist.
One patient was lost to follow-up in each group.

intravenous): 74 patients (53.2%) vs. 65 patients (35.7%) in the control group, $P < 0.01$. Vitamin D deficiency (<30 ng/mL) and malnutrition were also better screened and treated in the PCL cohort as 102 patients (73.4%) vs. 54 patients (29.7%) were treated with vitamin D ($P < 0.001$) and 41/44 patients (93.2%) with an albumin <35 g/L had a prescription of oral nutritional supplement vs. 18/45 (40%) in the control group ($P < 0.001$). There was no difference regarding the baseline and discharge doses of β-blockers, renin-angiotensin-aldosterone system blockers, or diuretics among groups. There was a higher referral to HF follow-up programme in the PCL group: 39 patients (28.1%) vs. 21 patients (11.5%), $P < 0.001$. There was no difference regarding telemedicine or cardiac rehabilitation programmes among groups.

Conclusions

The use of a PCL resulted in a non-significant improvement of the primary endpoint of death or readmission for HF at 6 months. It has been demonstrated that the administration of HF therapies, including β-blockers and renin-angiotensin-aldosterone system inhibitors, is associated with better survival of HF patients with a low LVEF.[9] In the present study, we sought to include nonselected patients, including patients with contraindications for the latter therapies (e.g. significant right ventricular dysfunction, cardiac amyloidosis, restrictive cardiomyopathy, or severe aortic stenosis). This may explain the lack of benefit in our small-sized study. However, we observed a significant improvement in the referral to follow-up programmes, the screening and the treatment of common comorbidities in HF patients. There is no therapeutic tool that had demonstrated any morbidity benefit in patients with HF and preserved LVEF. HF management is complicated by aging, co-morbid conditions, cognitive impairment, and frailty in elderly patients with preserved HF.[6] In the latter population, a multidisciplinary approach including systematic screening and treatment of comorbidities and deficiencies has to be evaluated.

In conclusion, the use of an algorithm-based PCL was associated with a significant higher referral to follow-up programmes and better screening and treatment of malnutrition and iron and vitamin D deficiencies in patients hospitalized for acute HF. However, there were no significant changes in outcomes at 6 months. A multicentre study is warranted to assess the usefulness of a simple costless personalized checklist in the setting of decompensated HF in a large HF patients population.

Conflict of interest

None declared.

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