Original article

Early Postdischarge STOP-HF-Clinic Reduces 30-day Readmissions in Old and Frail Patients With Heart Failure

Cristina Pacho,[a,b] Mar Domingo,[c] Raquel Núñez,[a] Josep Lupón,[b,c,d] Pedro Moliner,[c] Marta de Antonio,[b,c] Beatriz González,[c] Javier Santesmases,[a,c] Emili Vela,[e] Jordi Tor,[a,b] and Antoni Bayes-Genis[b,c,d,*]

[a] Servei de Medicina Interna y Unitat de Geriatria d'Aguts, Hospital Universitari Germans Trias i Pujol, Badalona, Barcelona, Spain
[b] Departament de Medicina, Universitat Autònoma de Barcelona, Barcelona, Spain
[c] Servei de Cardiologia-Unitat d'IC, Hospital Universitari Germans Trias i Pujol, Badalona, Barcelona, Spain
[d] CIBER-CV (CB16/11/00403), Instituto de Salud Carlos III, Madrid, Spain
[e] Divisió d'Anàlisi de la Demanda i l'Activitat, Servei Català de la Salut, Barcelona, Spain

Article history:
Received 31 October 2016
Accepted 21 December 2016
Available online 16 February 2017

Keywords:
Heart failure
Rehospitalizations
Elderly
Transitional care
Multidisciplinarity

A B S T R A C T

Introduction and objectives: Heart failure (HF) is associated with a high rate of readmissions within 30 days postdischarge. Strategies to lower readmission rates generally show modest results. To reduce readmission rates, we developed a STructured multidisciplinary outpatient clinic for Old and frail Postdischarge patients hospitalized for HF (STOP-HF-Clinic).

Methods: This prospective all-comers study enrolled patients discharged from internal medicine or geriatric wards after HF hospitalization. The intervention involved a face-to-face early visit (within 7 days), HF nurse education, treatment titration, and intravenous medication when needed. Thirty-day readmission risk was calculated using the CORE-HF risk score. We also studied the impact of 30-day readmission burden on regional health care by comparing the readmission rate in the STOP-HF-Clinic Referral Area (~250 000 people) with that of the rest of the Catalan Health Service (CatSalut) (~7.5 million people) during the pre–STOP-HF-Clinic (2012-2013) and post–STOP-HF-Clinic (2014-2015) time periods.

Results: From February 2014 to June 2016, 518 consecutive patients were included (age, 82 years; Barthel score, 70; Charlson index, 5.6, CORE-HF 30-day readmission risk, 26.5%). The observed all-cause 30-day readmission rate was 13.9% (47.5% relative risk reduction) and the observed HF-related 30-day readmission rate was 7.5%. The CatSalut registry included 65 131 index HF admissions, with 9267 all-cause and 6686 HF-related 30-day readmissions. The 30-day readmission rate was significantly reduced in the STOP-HF-Clinic Referral Area in 2014-2015 compared with 2012-2013 ($P < .001$), mainly driven by fewer HF-related readmissions.

Conclusions: The STOP-HF-Clinic, an approach that could be promptly implemented elsewhere, is a valuable intervention for reducing the global burden of early readmissions among elder and vulnerable patients with HF.

Una consulta específica al alta (*STOP-HF-Clinic*) reduce los reingresos a 30 días de los pacientes ancianos y frágiles con insuficiencia cardiaca

Palabras clave:
Insuficiencia cardiaca
Rehospitalizaciones
Ancianos
Cuidados transicionales
Multidisciplinariedad

R E S U M E N

Introducción y objetivos: La insuficiencia cardiaca (IC) se asocia a una alta tasa de reingreso en los 30 días posteriores al alta. Las estrategias para reducir los reingresos han mostrado, en general, resultados moderados. Hemos desarrollado una consulta multidisciplinaria estructurada ambulatoria para pacientes ancianos y frágiles tras el alta de un ingreso por IC *(STOP-HF-Clinic)*, con el objetivo de reducir estas tasas de reingreso.

Métodos: Estudio prospectivo que incluye a todos los pacientes dados de alta de medicina interna o geriatría tras una hospitalización por IC. Intervención: visita presencial temprana (antes de 7 días), educación sobre IC por enfermería, titulación del tratamiento y administración de medicamentos intravenosos cuando fuera necesario. El riesgo de reingreso a 30 días se calculó utilizando la puntuación de riesgo CORE-HF. También se estudió el impacto de la carga de reingresos a 30 días en la atención sanitaria regional comparando la tasa de reingresos en el área de referencia de la *STOP-HF-Clinic*

SEE RELATED CONTENT:
http://dx.doi.org/10.1016/j.rec.2017.03.007, *Rev Esp Cardiol.* 2017;70:624–625.

* Corresponding author: Servicio de Cardiología, Hospital Universitari Germans Trias i Pujol, Carretera del Canyet s/n, 08916 Badalona, Barcelona, Spain.
E-mail address: abayesgenis@gmail.com (A. Bayes-Genis).

http://dx.doi.org/10.1016/j.rec.2017.01.003

(~250.000 personas) con la del resto del *Servei Català de la Salut* (CatSalut) (~7,5 millones de personas) durante 2 periodos de tiempo, antes de la *STOP-HF-Clinic* (2012-2013) y después (2014-2015).
Resultados: De febrero de 2014 a junio de 2016, se incluyó a 518 pacientes consecutivos (media de edad, 82 años; índice de Barthel, 70; índice de Charlson, 5,6; riesgo a 30 días de reingreso según la puntuación CORE-HF, 26,5%). La tasa de reingreso a 30 días por todas las causas observadas fue del 13,9% (reducción del riesgo relativo, el 47,5%), y la tasa de reingreso por IC a 30 días observada fue del 7,5%. El registro del CatSalut incluyó 65.131 ingresos índice por IC, con 9.267 reingresos a 30 días por todas las causas y 6.686 por IC. La tasa de reingresos a 30 días se redujo significativamente en el área de referencia de la *STOP-HF-Clinic* en 2014-2015 en comparación con 2012-2013 ($p < 0,001$), a expensas principalmente de la reducción de los reingresos por IC.
Conclusiones: La *STOP-HF-Clinic*, iniciativa que podría aplicarse sin demora en otros lugares, es una valiosa intervención para reducir la carga total de reingresos prematuros de los pacientes con IC mayores y frágiles.

Abbreviations

CatSalut: Catalan Health Service
HF: heart failure
NT-proBNP: N-terminal pro–B-type natriuretic peptide

INTRODUCTION

Heart failure (HF) is the leading cause of hospital readmission in developed countries.[1] It is a particular concern for patients ≥ 65 years of age, who comprise approximately 80% of the population with HF.[2] The total annual cost of HF in the US is estimated to be $30.7 billion, with about two-thirds attributable to HF-related hospitalizations.[3]

Rates of rehospitalization within 30 days of discharge can reach 20%–30%.[4] Early rehospitalization is attributed to underlying disease exacerbation[5] and several other medical derangements.[6] Up to 65% of 30-day readmissions are for diverse medical circumstances[7] that often occur early in the hospital-to-home transition.[8] Early postdischarge readmissions are strongly linked to the quality of inpatient care.[9,10] Although they may be partly due to incomplete patient stabilization, they are frequently caused by poor discharge coordination and failure to ensure good quality postdischarge care. Indeed, up to 75% of such cases are considered to be preventable.[11]

Several interventions have been proposed and tested for reducing the social and economic burdens of early readmissions.[12,13] However, previously tested interventions show only modest ability to reduce all-cause or unplanned 30-day postdischarge readmissions among patients hospitalized for HF, with absolute reductions of around 2%-3% (relative reductions of 10%-18%).[12,14] Moreover, some studies exclude HF patients admitted to noncardiology wards, although these patients are usually elderly, frail, and have several comorbidities, and thus show the highest readmission rates.[15]

In the present study, we evaluated a STructured multidisciplinary outpatient clinic for Old and frail postdischarge patients hospitalized for HF (the "STOP-HF-Clinic"), which was established with the aim of reducing 30-day readmission rates and facilitating transition to primary care. We assessed the efficacy of this STOP-HF intervention in terms of the enrolled patients' 30-day readmission rates compared with their readmission risk calculated using the CORE-HF risk score. As a secondary objective, we examined the impact of the STOP-HF-Clinic intervention within the official readmission data registry of the Catalan Health Service (CatSalut), which provides medical care to 7.5 million people in Catalonia, Spain.

METHODS

Study Population

This prospective single-center study was designed to include the most vulnerable patients admitted for acutely decompensated HF. We performed an all-comers, consecutive study of HF patients discharged from internal medicine and geriatric wards with a primary hospital diagnosis of HF according to the Framingham HF Criteria.[16] Our study did not include patients discharged from the cardiology ward (n = 106 during the study time period), who were generally younger (64 ± 12 years), male (76%), of ischemic etiology (51%), and with reduced left ventricular ejection fraction (30% ± 9%). Such patients received standard follow-up care by HF specialists.

At their first study visit, patients' 30-day readmission risk was calculated using the Yale Center for Outcome Research and Evaluation score (CORE-HF).[17] This calculator estimates risk using 20 demographic, clinical, and hemodynamic variables and is based on medical record chart models developed to allow the Centers for Medicare and Medicaid Services to validate publicly reported readmission measures.[18] At the first study visit, we also obtained the Charlson comorbidity index and Barthel functional score and clinical, demographic, and treatment data. All participants provided written informed consent, and the study was approved by the local ethics committee. All study procedures were in accordance with the ethical standards outlined in the Helsinki Declaration of 1975, as revised in 2013.[19]

STOP-HF-Clinic Intervention

Seven different interventions were applied in the STOP-HF-Clinic: *a)* within 7 days after discharge, an early postdischarge visit was scheduled for patients at a specialized HF faculty including a HF nurse and one or more clinic staff, such as a general practitioner, internist, geriatrician, or cardiologist; *b)* participants were examined for residual congestion and other reversible potentially decompensating conditions; *c)* a baseline blood sample was taken to test biomarker levels, including N-terminal pro–B-type natriuretic peptide (NT-proBNP), hemoglobin, and the estimated glomerular filtration rate; *d)* HF nurses performed a face-to-face educational intervention with both the patient and the caregiver. Advice was personalized and supported by an educational booklet and a telephone hotline number; *e)* a minimum of 3 visits were planned for drug adjustment during the 30-day period, with as many extra visits as required. Based on the first evaluation and treatment upon discharge, drug titration was individualized according to clinical guidelines. Diuretics were adjusted based on the patient's congestive state; *f)* intravenous treatments, such as furosemide, ferric carboxymaltose, and red blood cell transfusions, were administered as necessary; *g)* after 30 days, patients were transitioned to their general practitioner and/or specialist for an early follow-up via e-notification, and a written medical report and drug prescription information were uploaded to the electronic medical record.

The primary endpoints were all-cause and HF-related 30-day hospital readmissions among patients who attended the STOP-HF-Clinic. Outpatient medical visits and hospital admissions were reviewed using the electronic medical records.

Catalan Health Service Registry

To evaluate the efficacy of the STOP-HF intervention in a real-world setting, we designed a population-based natural experiment including all patients admitted with HF in Catalonia, Spain, between 2012 and 2015. The STOP-HF-Clinic was conducted in the referral area for ∼250 000 inhabitants in the north Barcelona Metro Area (referred to as the STOP-HF Referral Area). CatSalut provides medical care to 7.5 million people in Catalonia, Spain.

Our analysis included all patients with HF who were consecutively admitted to any Catalan hospital and discharged alive between January 2012 and December 2015. We analyzed all-cause 30-day readmissions, which were classified as either HF-related (due to HF recurrence) or non–HF-related (readmission with a primary diagnosis of chronic disease not involving the circulatory system and with no external cause or due to a complication of the index admission). For the index admission and successive clinically related readmissions, we considered only unplanned acute admissions lasting longer than 24 hours. The International Classification of Diseases-9-CM codes used for hospital admissions for HF were 398.91, 402.x1, 404.x1, 404.x3, 428.0, 428.1, 428.2x, 428.3x, and 428.4x. For the diagnosis of both HF and clinically related readmissions, we used the criteria recommended in the Chronic Condition Indicator of the Agency for Healthcare Research and Quality.[20] The registry has an automatic data validation system, and an external audit is carried out periodically to ensure data quality and accuracy.

As a secondary endpoint, we evaluated the population-based impact on all-cause and HF-related 30-day readmissions of patients within the STOP-HF Referral Area before the program started (2012-2013) and after exposure to the STOP-HF-Clinic (2014-2015). The control group comprised all patients in the rest of the CatSalut area.

Statistical Analysis

Continuous variables are expressed as mean ± standard deviation or as median and [interquartile range, Q1-Q3], depending on data distribution (assessed by normal Q-Q plots). Categorical variables are expressed as number (percentage). Comparative analyses between variables were performed using the chi-square test, *t* test, or Mann-Whitney U test, depending on the variable type (dichotomous or continuous) and distribution type. Multivariable logistic regression analyses were performed to determine the variables associated with all-cause and HF-related 30-day readmissions. The model included variables determined to be significant in univariable analysis or considered potentially clinically relevant, such as age, sex, HF etiology, Barthel score, Charlson index, length of index hospital stay, CORE-HF risk prediction, and Framingham score and NT-proBNP at first visit. A conditional backward stepwise method was used to avoid over-adjustments. For NT-proBNP, we used its logarithmic function and a 1-standard deviation increase for odds ratio (OR) calculations. Actuarial HF readmission curves were obtained for the CatSalut area during the 2 studied periods and were compared with those of the STOP-HF Referral area using the Wilcoxon-Gehan test. Statistical analyses were performed using SPSS 15 (SPSS Inc, Chicago, IL, United States). *P* values of < .05 from 2-sided tests were considered to indicate statistical significance.

RESULTS

A total of 518 patients attended the STOP-HF-Clinic from February 2014 to June 2016. These patients' demographic and clinical characteristics are shown in Table 1. The mean patient age was 82.3 ± 8.3 years, 25% were ≥ 88 years old, and 57.1% were women. Common comorbidities included diabetes, anemia, and renal failure. Hemoglobin levels were < 10 g/dL in 55 patients (10.6%) and < 9 g/dL in 13 patients (2.5%). The median time from discharge to first STOP-HF-Clinic visit was 5 days (Q1-Q3, 3-6 days), and the mean number of visits per patient within 30 days was 3.1 ± 1.2.

The need for intravenous therapy and adjustment of HF treatment in the 30-day STOP-HF-Clinic are displayed in Table 2. One-third of patients required at least one infusion of 40 mg intravenous furosemide. Infusions of intravenous furosemide were required once by 104 patients, twice by 39 patients, 3 times by 21 patients, 4 times by 11 patients, 5 times by 4 patients, and 6 times by 3 patients. One-sixth of patients required intravenous ferric carboxymaltose 1 g, with up to 93 infusions needed. Twenty-one patients required red blood cell transfusion. Oral HF treatments were routinely initiated or adjusted in the STOP-HF-Clinic, with some patients requiring substantial dose uptitration. Angiotensin-converting enzyme inhibitors/angiotensin receptor blockers were discontinued in 10.5% of patients due to renal worsening or hypotension. Those who continued treatment had a mean angiotensin-converting enzyme inhibitor/angiotensin receptor blocker dose increase of 15% after the 30-day follow-up. During the 30-day follow-up period, 12 patients (2.3%) died. At the end of the intervention, 54% of patients were transitioned to their general practitioner and 30% to a primary care specialist and 16% continued follow-up with hospital HF specialists.

The predicted CORE-HF all-cause 30-day readmission risk was 26.5% ± 5.3%, with 29.5% of patients having a CORE-HF risk of ≥ 30%. The observed all-cause 30-day readmission rate was 13.9% (n = 72), and the observed HF-related 30-day readmission rate was 7.5% (n = 39). Overall, the STOP-HF-Clinic intervention achieved a 47.5% relative reduction in all-cause 30-day readmission risk and an absolute reduction of 12.6% compared with the predicted CORE-HF readmission risk score.

Multivariable logistic regression analysis revealed that all-cause 30-day readmission was independently associated with age (OR, 1.04; 95% confidence interval [95%CI], 1.00-1.08; *P* = .03), Charlson index (OR, 1.19; 95%CI, 1.06-1.34; *P* = .005), length of index hospital stay (OR, 1.03; 95%CI, 1.00-1.06; *P* = .03), and NT-proBNP (OR, 1.34; 95%CI, 1.01-1.78; *P* = .045). On the other hand, HF-related 30-day readmission was independently associated with only the Charlson index (OR, 1.22; 95%CI, 1.05-1.41; *P* = .008) and NT-proBNP (OR, 1.43; 95%CI, 1.00-2.05; *P* = .05).

We next compared readmission rates within the STOP-HF Referral Area (∼250 000 people) with readmission rates within the entire CatSalut registry (∼7.5 million people) during 2 time periods: pre–STOP-HF (2012-2013) and post–STOP-HF (2014-2015) (table of the supplementary material). Within these 2 periods, 9267 all-cause and 6686 HF-related 30-day readmissions were documented after a total of 65 131 index HF-related

Table 1
Demographic and Clinical Characteristics

	Total cohort (n = 518)	No readmission (n = 446)	All-cause readmission (n = 72)	P
Age, y	82.3 ± 8.3	81.9 ± 8.7	84.2 ± 6.2	.04
Female sex	296 (57.1)	255 (57.2)	41 (56.9)	.97
Etiology				.96
Hypertensive	201 (38.8)	171 (38.3)	30 (41.7)	
Ischemic	143 (27.6)	124 (27.8)	19 (26.4)	
Valvular	75 (14.5)	64 (14.3)	11 (15.3)	
Other	93 (18.1)	82 (18.4)	11 (15.3)	
Referral ward				.26
Geriatric	248 (47.9)	206 (46.2)	42 (58.3)	
Internal medicine	202 (39.0)	179 (40.1)	23 (31.9)	
Other wards	68 (13.1)	19 (4.3)	3 (4.2)	
NHYA functional class				.96
I-II	203 (39.2)	175 (39.2)	28 (38.9)	
III-IV	315 (60.8)	271 (60.8)	44 (61.1)	
LVEF, %[a]	56.1 ± 13.9	55.9 ± 13.8	57.6 ± 14.2	.42
Framingham score ≥ 2	70 (13.5)	57 (12.8)	13 (18.1)	.22
NT-proBNP	2880 [1393-5848]	2730 [1340-5670]	3880 [2045-6840]	< .001
Diabetes	275 (53.1)	237 (53.1)	38 (52.8)	.23
Anemia[b]	348 (67.2)	298 (66.8)	50 (69.4)	.66
Renal insufficiency[c]	415 (80.1)	352 (78.9)	63 (87.5)	.09
Barthel score	70.5 ± 25	72.6 ± 24.6	63.8 ± 26.7	.01
Barthel score < 60	146 (28.2)	117 (26.3)	19 (40.3)	.01
Charlson index	5.6 ± 2.2	5.5 ± 2.1	6.4 ± 2.5	.001
Charlson index ≥ 6	251 (48.5)	208 (46.7)	43 (59.7)	.04
Index hospitalization stay, d	10 [7.0-15.0]	10 [7.0-14.0]	11.5 [7.0-19.8]	.04
STOP-HF first visit, d	5 (3-6)	5 (3-6)	5 (3-6)	.24
CORE-HF risk readmission	26.5 ± 5.3	26.4 ± 5.4	27.1 ± 4.6	.30
Treatments at first visit				
ACE inhibitor or ARB	305 (58.9)	275 (61.7)	30 (41.7)	.001
Beta-blockers	311 (60.0)	270 (60.5)	41 (56.9)	.56
MRA	122 (23.6)	110 (24.7)	12 (16.7)	.14
Loop diuretics	510 (98.5)	439 (98.4)	71 (98.6)	.91
Digoxin	102 (19.7)	89 (20.0)	13 (18.1)	.71
Ivabradine	19 (3.7)	18 (4.0)	1 (1.4)	.27
Hydralazine	153 (29.5)	118 (26.5)	35 (48.6)	< .001
Nitrates	188 (36.3)	156 (35.0)	32 (44.4)	.12

ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blockers; CORE-HF, Yale Center for Outcome Research and Evaluation score; LVEF, left ventricular ejection fraction; MRA, mineralocorticoid receptor antagonist; NT-proBNP: N-terminal pro-B-type natriuretic peptide; NYHA, New York Heart Association; STOP-HF, structured multidisciplinary outpatient clinic for old and frail postdischarge patients hospitalized for heart failure.
Data are expressed as no. (%), mean ± standard deviation or median [interquartile range, Q1-Q3].
[a] Available in 380 patients.
[b] Hemoglobin of < 13 g/dL in men and < 12 g/dL in women.
[c] Estimated glomerular filtration rate < 60 mL/min/1.73 m^2.

admissions. Figure 1 illustrates the decline in 30-day readmission rates observed in the STOP-HF Referral Area during the 2014-2015 time period compared with the 2012-2013 time period ($P < .001$), with no significant changes in the rest of the CatSalut area ($P = .11$). The all-cause 30-day readmission rates during the 2012-2013 period in the 2 studied populations are shown in Table 3 ($P = .88$). On the other hand, during the 2014-2015 period, all-cause 30-day readmission rates were significantly lower in the STOP-HF Referral Area ($P < .001$), which was mainly driven by reduced HF-related readmissions.

Actuarial curves of probability after HF hospitalization within the CatSalut area and the STOP-HF Referral Area are shown in Figure 2. Compared with the rest of the CatSalut area, the STOP-HF Referral Area showed a significant decline in HF readmissions during the 2014-2015 period, with the 2 curves following divergent paths after day 10.

DISCUSSION

The concept that "hospitalization begets further hospitalization" is certainly applicable to HF.[21] Because many HF readmissions are considered preventable, novel strategies are needed to reduce rehospitalizations. We have developed a comprehensive patient-centered model: the STOP-HF-Clinic. Our present data show that implementation of the STOP-HF-Clinic intervention was associated with a significant ~50% reduction in all-cause 30-day readmission, mainly driven by reduced HF-related readmissions.

Table 2
Intravenous Treatment and Changes in Oral Heart Failure Drugs During STOP-HF-Clinic Follow-up

Intravenous treatment	Patients, no.	Infusions, no.
Furosemide, 40 mg	182	327
Ferric carboxymaltose, 1 g	86	93
Red blood cell transfusion	21	37
Oral HF drug adjustments	**Initiated/discontinued, %[a]**	**Dose uptitration, %[b]**
ACE inhibitor/ARB	−10.5	+15.0
Beta-blockers	+4.7	+11.2
MRA	+29.8	+2.0
Loop diuretics	0.0	+35.5
Digoxin	+11.4	–
Ivabradine	+35.2	–
Hydralazine	+4.2	–
Nitrates	+9.0	–

ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blockers; HF, heart failure; MRA, mineralocorticoid receptor antagonist; STOP-HF, structured multidisciplinary outpatient clinic for old and frail postdischarge patients hospitalized for heart failure.
[a] Patient percentage that initiated a HF drug (positive %) or discontinued a drug (negative %).
[b] Mean percent dose uptitration during follow-up.

Moreover, the STOP-HF intervention profoundly impacted all-cause readmission rates in the STOP-HF Referral Area compared with the CatSalut registry.

Rather than focusing on only one aspect of patient care, the STOP-HF-Clinic integrated a number of interventions, including quality of medical management, early reassessment, health literacy, and care transition. Despite growing interest in remote monitoring of these patients to reduce readmissions, structured telephone support interventions and home telemonitoring have not shown greater ability to reduce 30-day all-cause or HF-related readmission rates.[22] Recent reports from the BEAT-HF trial, which aimed to explicitly adapt the care transition approach in combination with remote telemonitoring, failed to demonstrate reduced all-cause 30-day and 180-day readmission rates.[23] On the other hand, our face-to-face early intervention reduced both all-cause and HF-related 30-day readmissions in our population.

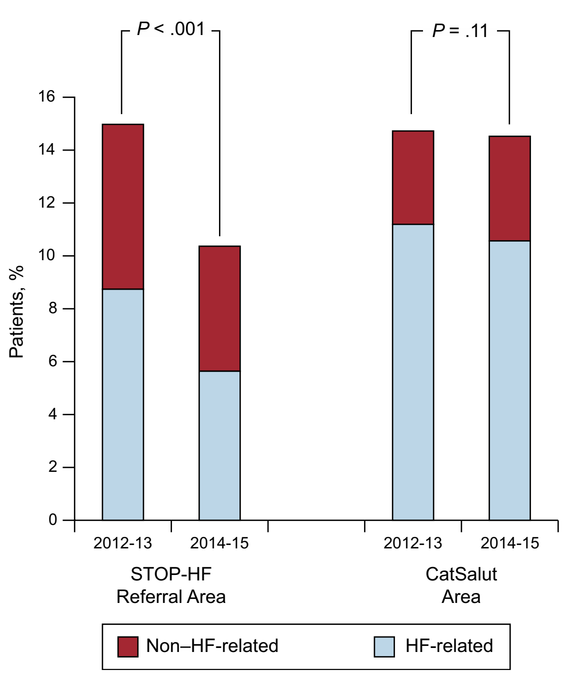

Figure 1. Thirty-day readmission rates with and without the STOP-HF intervention. Thirty-day readmission rates in the STOP-HF Referral Area vs the CatSalut area before STOP-HF (2012-2013) and with STOP-HF (2014-2015). CatSalut, Catalan Health Service; HF-related, heart failure recurrence; non–HF-related: chronic noncirculatory disease and readmissions due to a complication of the index admission; STOP-HF, structured multidisciplinary outpatient clinic for old and frail postdischarge patients hospitalized for heart failure.

Compared with most prior studies, our present real-life, prospective, all-comers study enrolled patients who were older and more frail and vulnerable in terms of medical complexity (mean age, 82 years; Barthel score, 70; Charlson index, 6; preserved left ventricular ejection fraction and high NT-proBNP).[24–31] Previous studies have commonly excluded patients with advanced renal insufficiency or severe cardiovascular disease[22] but elderly individuals with prevalent renal dysfunction and prominent congestion are most prone to early readmissions.[32] The prospect of an increasingly aging frail population increases the need for solutions suitable for this patient group. Such measures will likely require the cooperation of multidisciplinary teams, such as in the STOP-HF-Clinic, rather than a focus on any one aspect of patient care.

It appears that early follow-up within 7 days of discharge is critical for reducing readmissions.[21,33,34] In the STOP-HF-Clinic, we offered systematic medical contact at a median of 5 days postdischarge. During this transitional period, ineffective communication, low health literacy, and adherence issues contribute to readmissions. However, intervention programs often fail to act during this time frame,[35] sometimes due to a lack of coordination with the medical provider, revealing a gap in transitional care. This period of postdischarge vulnerability has been described as "post-hospital syndrome"[36] and is related to factors such as age, cognitive impairment, frailty, and polypharmacy. The STOP-HF intervention likely acted to prevent 'post-hospital syndrome'.

The STOP-HF-Clinic provided a quick therapeutic intervention to promote disease stability. Indeed, the reduced readmission rate was likely affected by the high number of intravenous infusions of both furosemide and ferric carboxymaltose. Although intravenous loop diuretics are the standard-of-care for inpatient management in acutely decompensated HF, here we extended intravenous furosemide infusion to the outpatient setting during the 30-day postdischarge period among patients with refractory HF and congestion. This is not a widespread practice, although it has shown benefits as part of transitional care in some case series, promoting symptom improvement and avoidance of emergency department transfers and readmissions.[37–40] Moreover, the CONFIRM-HF trial showed that iron replacement with ferric carboxymaltose significantly reduced the risk of hospitalization due to worsening heart failure, regardless of functional class severity, and had particular benefits in patients with diabetes or renal impairment,[41] such as in our cohort, which comprised over 50% diabetic patients and 80% patients with renal insufficiency.

Table 3
Catalan Health Service Population-based Data During the 2 Studied Periods

2012-2013 period			
	STOP-HF Referral Area	CatSalut	*P*
Total HF admissions, no.	1253	31 199	
All-cause 30-day readmissions, no. (%)	184 (14.7)	4533 (14.5)	.88
HF-related[a]	108 (8.6)	3335 (10.7)	.02
Non–HF-related[b]	76 (6.1)	1198 (3.8)	< .001
2014-2015 period			
	STOP-HF Referral Area	CatSalut	*P*
Total HF admissions, no.	1296	31 383	
All-cause 30-day readmissions, no. (%)	130 (10.0)	4420 (14.1)	< .001
HF-related[a]	71 (5.5)	3172 (10.1)	< .001
Non–HF-related[b]	59 (4.5)	1248 (4.0)	.30

CatSalut, Catalan Health Service; HF, heart failure; STOP-HF, structured multidisciplinary outpatient clinic for old and frail postdischarge patients hospitalized for heart failure.
[a] Recurrence of heart failure.
[b] Discharges with a primary diagnosis of chronic disease not involving the circulatory system and with no external cause, and readmissions due to a complication of the index admission.

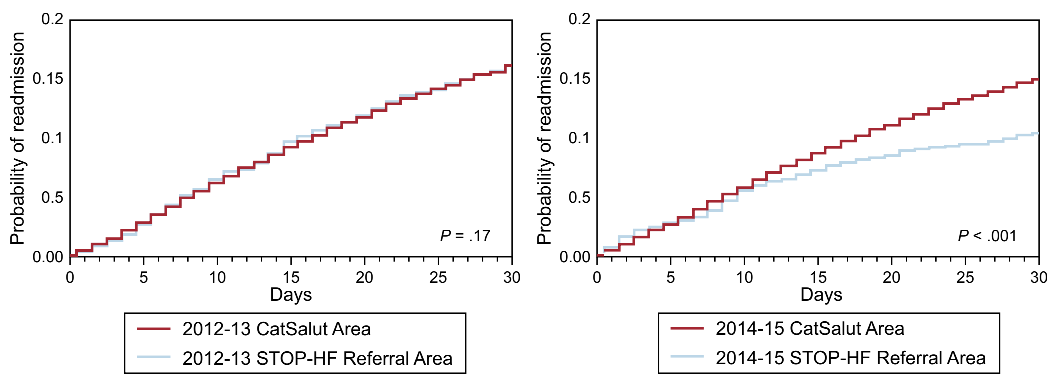

Figure 2. Actuarial curves of the probability of 30-day readmission with and without STOP-HF. Probabilities of 30-day readmission in the STOP-HF Referral Area vs the CatSalut area before STOP-HF (2012-2013) and with STOP-HF (2014-2015). *P* values reflect comparisons between study groups. CatSalut, Catalan Health Service; STOP-HF, structured multidisciplinary outpatient clinic for old and frail postdischarge patients hospitalized for heart failure.

It seems clear that transition care interventions can reduce readmissions. As Comín-Colet et al. noted in a recent review article,[42] a paradigm shift in the management of chronic diseases has taken place in recent years. This new approach is based on the development of a multidisciplinary model that provides integrated care to patients with HF throughout the duration of the disease, ensuring a successful follow-up and transition of care to different health care settings depending on the progress of the condition. In our case, the STOP-HF Clinic is included in a specialized HF unit that fulfills the standards recommended by the Spanish Society of Cardiology.[43]

Moreover, readmission risk assessment tools may help to appropriately target the delivery of these interventions to at-risk patients. Here, we predicted readmission risk using a validated risk score (the CORE-HF calculator). Although our cohort substantially differed from the population used to derive this score,[18] we believe than the CORE-HF tool was appropriate given the high-risk population studied. However, it is notable that a reliable readmission predictive model for the current "real-life" population is not yet available.

Regarding our secondary endpoint, the present study was designed as a natural experiment rather than a conventional clinical trial. Our analysis included all patients within the STOP-HF Referral Area, regardless of their participation in the STOP-HF-Clinic. Their course was compared with that of a control group comprising the patients in the rest of the CatSalut area. This procedure minimized the characteristic selection bias of clinical trials, whose patient profile is often distinct from that of the general population and more pragmatically reflects the efficacy of the intervention. Our data revealed that the STOP-HF intervention had remarkable benefits during the post–STOP-HF period (2014-2015) compared with the pre–STOP-HF period (2012-2013) in terms of indicators relevant to the health care system and the patients (all-cause and HF-related 30-day readmissions).

Limitations

Although the current data reveal an association between the initiative implemented in our area and the improvement in clinical outcomes compared with the rest of the CatSalut area, population-based natural studies have limited ability to establish causality. Nevertheless, the inclusion of all patients admitted to hospitals in Catalonia for HF during the study period enabled us to avoid the selection bias inherent to clinical trials and to improve the generalizability of the results. Another limitation was our inability to determine the most effective component of the STOP-HF-Clinic design. Thus, the results of the STOP-HF-Clinic must be analyzed as a whole. While there is certainly room for improvement in our interventional design, our approach accounts for the multiple comorbidities encountered in the HF population and better reflects an intervention that, although focused on HF, was designed for the integrated care of old and frail patients in their transition from hospital to home.

CONCLUSIONS

The STOP-HF-Clinic included early follow-up, HF nurses tasked with medication reconciliation, education and patient self-care empowerment, staff assigned to follow up on postdischarge test results, immediate availability of intravenous treatments and patient treatment titration, and partnerships with community physicians. This intervention resulted in an ~50% reduction in the all-cause 30-day readmission rate after an index hospitalization for HF, which was mainly driven by a reduction in HF-related readmissions. Our results with the STOP-HF-Clinic in an elderly and frail comorbid population were better than with previously reported strategies. Our present data support the value of the STOP-HF-Clinic, an approach that could be implemented elsewhere to reduce the global burden of HF readmissions.

ACKNOWLEDGEMENTS

We thank the nurses of the STOP-HF-Clinic—Roser Cabanes, Margarita Rodríguez, Carmen Rivas, Nuria Benito, and Alba Ros—for data collection and their invaluable work in the Clinic. This study was funded by the *Red de Investigación Cardiovascular* - RIC (RD12/0042/0047) and *Fondo de Investigación Sanitaria, Instituto de Salud Carlos III* (FIS PI14/01682) projects as part of the *Plan Nacional de I+D+I* and was cofunded by the *ISCIII-Subdirección General de Evaluación* and the *Fondo Europeo de Desarrollo Regional* (FEDER).

CONFLICTS OF INTEREST

None declared.

WHAT IS KNOWN ABOUT THE TOPIC?

– Heart failure is associated with a high rate of readmissions within 30 days postdischarge.
– Old and frail patients are the most vulnerable and prone to require premature readmission after being hospitalized for HF.
– Strategies to lower these readmission rates have generally shown modest results.

WHAT DOES THIS STUDY ADD?

– An early postdischarge multidisciplinary approach including face-to-face health literacy, intravenous therapy, and improved primary care transition significantly reduced 30-day readmission rates among discharged HF patients.
– This early multidisciplinary hospital-based intervention for the most vulnerable patients with HF reduced the global readmission burden, as shown in a population-based natural experiment including all HF readmissions in Catalonia, Spain, between 2012 and 2015.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found in the online version available at: http://dx.doi.org/10.1016/j.rec.2017.01.003.

REFERENCES

1. Fonarow GC. Epidemiology and risk stratification in acute heart failure. *Am Heart J.* 2008;155:200–207.
2. Bui AL, Horwith TB, Fonarow GC. Epidemiology and risk profile of heart failure. *Nat Rev Cardiol.* 2011;8:30–41.
3. Mozaffarian D, Benjamin EJ, Go AS, et al. Heart disease and stroke statistics–2016 update: a report from the American Heart Association. *Circulation.* 2016;133:447–454.
4. Dharmarajan K, Krumholz HM. Strategies to reduce 30-day readmissions in older patients hospitalized with heart failure and acute myocardial infarction. *Curr Geriatr Rep.* 2014;3:306–315.
5. Comín-Colet J, Verdú-Rotellar JM, Vela E, et al. Efficacy of an integrated hospital-primary care program for heart failure: a population-based analysis of 56 742 patients. *Rev Esp Cardiol.* 2014;67:283–293.
6. Krumholz HM, Merrill AR, Schone EM, et al. Patterns of hospital performance in acute myocardial infarction and heart failure 30-day mortality and readmission. *Circ Cardiovasc Qual Outcomes.* 2009;2:407–413.
7. Dharmarajan K, Hsieh AF, Lin Z, et al. Diagnoses and timing of 30-day readmissions after hospitalization for heart failure, acute myocardial infarction, or pneumonia. *JAMA.* 2013;309:355–363.
8. Desai AS, Stevenson LW. Rehospitalization for heart failure: predict or prevent? *Circulation.* 2012;126:501–506.
9. Ashton CM, Kuykendall DH, Johnson ML, Wray NP, Wu L. The association between the quality of inpatient care and early readmission. *Ann Intern Med.* 1995;122:415–421.
10. Ashton CM, Del Junco DJ, Souchek J, Wray NP, Mansyur CL. The association between the quality of inpatient care and early readmission: a meta-analysis of the evidence. *Med Care.* 1997;35:1044–1059.
11. Van Walraven C, Bennett C, Jennings A, Austin PC, Forster AJ. Proportion of hospital readmissions deemed avoidable: a systematic review. *CMAJ.* 2011;183:E391–E402.
12. Bradley EH, Curry L, Horwitz LI, et al. Hospital strategies associated with 30-day readmission rates for patients with heart failure. *Circ Cardiovasc Qual Outcomes.* 2013;6:444–450.
13. McAlister FA, Stewart S, Ferrua S, McMurray JJ. Multidisciplinary strategies for the management of heart failure patients at high risk for admission: a systematic review of randomized trials. *J Am Coll Cardiol.* 2004;44:810–819.
14. Leppin AL, Gionfriddo MR, Kessler M, et al. Preventing 30-day hospital readmissions: a systematic review and meta-analysis of randomized trials. *JAMA Intern Med.* 2014;174:1095–1107.
15. Parmar KR, Xiu PY, Chowdhury MR, Patel E, Cohen M. In-hospital treatment and outcomes of heart failure in specialist and non-specialist services: a retrospective cohort study in the elderly. *Open Heart.* 2015;2:e000095.
16. Ho KK, Anderson JM, Kannel WB, Grossman W, Levy D. Survival after the onset of congestive heart failure in Framingham Heart Study subjects. *Circulation.* 1993;88:107–115.
17. Readmission risk score for heart failure. Available at: http://www.readmissionscore.org/heart_failure.php. Cited 20 Dec 2016.
18. Keenan PS, Normand SL, Lin Z, et al. An administrative claims measure suitable for profiling hospital performance on the basis of 30-day all-cause readmission rates among patients with heart failure. *Circ Cardiovasc Qual Outcomes.* 2008;1:29–37.
19. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA.* 2013;310:2191–2194.
20. Chronic condition indicator (CCI) for the ICD-9-CM. Available at: http://www.hcup-us.ahrq.gov/toolssoftware/chronic/chronic.jsp. Accessed 21 Oct 2013.
21. Hernandez AF, Greiner MA, Fonarow GC, et al. Relationship between early physician follow-up and 30-day readmission among Medicare beneficiaries hospitalized for heart failure. *JAMA.* 2010;303:1716–1722.
22. Feltner C, Jones CD, Cené CW, et al. Transitional care interventions to prevent readmissions for persons with heart failure: a systematic review and meta-analysis. *Ann Intern Med.* 2014;160:774–784.
23. Ong MK, Romano PS, Edgington S, et al. Better effectiveness after transition–heart failure (BEAT-HF) research group. Effectiveness of remote patient monitoring after discharge of hospitalized patients with heart failure: the better effectiveness after transition - heart failure (BEAT-HF) randomized clinical trial. *JAMA Intern Med.* 2016;176:310–318.
24. Albert NM, Barnason S, Deswal A, et al. Transitions of care in heart failure: a scientific statement from the American Heart Association. *Circ Heart Fail.* 2015;8:384–409.
25. Cline CM, Israelsson BY, Willenheimer RB, Broms K, Erhardt LR. Cost effective management programme for heart failure reduces hospitalisation. *Heart.* 1998;80:442–446.
26. Ledwidge M, Barry M, Cahill J, et al. Is multidisciplinary care of heart failure cost-beneficial when combined with optimal medical care? *Eur J Heart Fail.* 2003;5:381–389.
27. Ekman I, Andersson B, Ehnfors M, Matejka G, Persson B, Fagerberg B. Feasibility of a nurse-monitored, outpatient-care programme for elderly patients with moderate-to-severe, chronic heart failure. *Eur Heart J.* 1998;19:1254–1260.
28. Doughty RN, Wright SP, Pearl A, et al. Randomized, controlled trial of integrated heart failure management. The Auckland Heart Failure Management Study. *Eur Heart J.* 2002;23:139–146.

29. Kasper EK, Gerstenblith G, Hefter G, et al. A randomized trial of the efficacy of multidisciplinary care in heart failure outpatients at high risk of hospital readmission. *J Am Coll Cardiol.* 2002;39:471–480.
30. Capomolla S, Febo O, Ceresa M, et al. Cost/utility ratio in chronic heart failure: comparison between heart failure management program delivered by day-hospital and usual care. *J Am Coll Cardiol.* 2002;40:1259–1266.
31. Stromberg A, Martensson J, Fridlund B, Levin LA, Karlsson JE, Dahlström U. Nurse-led heart failure clinics improve survival and self-care behaviour in patients with heart failure: results from a prospective, randomised trial. *Eur Heart J.* 2003;24:1014–1023.
32. Vader JM, LaRue SJ, Stevens SR, et al. Timing and causes of readmission after acute heart failure hospitalization-insights from the Heart Failure Network Trials. *J Card Fail.* 2016;22:875–883.
33. Lee KK, Yang J, Hernandez AF, Steimle AE, Go AS. Post-discharge follow-up characteristics associated with 30-day readmission after heart failure hospitalization. *Med Care.* 2016;54:365–372.
34. Baker H, Oliver-McNeil S, Deng L, Hummel SL. Regional hospital collaboration and outcomes in medicare heart failure patients: see you in 7. *JACC Heart Fail.* 2015;3:765–773.
35. DeVore AD, Cox M, Eapen ZJ, et al. Temporal trends and variation in early scheduled follow-up after a hospitalization for heart failure findings from get with the guidelines-heart failure. *Circ Heart Fail.* 2016. http://dx.doi.org/10.1161/CIRCHEARTFAILURE.115.002344.
36. Krumholz HM. Post-hospital syndrome–an acquired, transient condition of generalized risk. *N Engl J Med.* 2013;368:100–102.
37. Buckley LF, Carter DM, Matta L, et al. Intravenous diuretic therapy for the management of heart failure and volume overload in a multidisciplinary outpatient unit. *JACC Heart Fail.* 2016;4:1–8.
38. Lazkani M, Ota KS. The role of outpatient intravenous diuretic therapy in a transitional care program for patients with heart failure: a case series. *J Clin Med Res.* 2012;4:434–438.
39. Hebert K, Dias A, Franco E, Tamariz L, Steen D, Arcement LM. Open access to an outpatient intravenous diuresis program in a systolic heart failure disease management program. *Congest Heart Fail.* 2011;17:309–313.
40. Ryder M, Murphy NF, McCaffrey D, O'Loughlin C, Ledwidge M, McDonald K. Outpatient intravenous diuretic therapy; potential for marked reduction in hospitalisations for acute decompensated heart failure. *Eur J Heart Fail.* 2008;10:267–272.
41. Ponikowski P, Van Veldhuisen DJ, Comin-Colet J, et al. CONFIRM-HF Investigators. Beneficial effects of long-term intravenous iron therapy with ferric carboxymaltose in patients with symptomatic heart failure and iron deficiency. *Eur Heart J.* 2015;36:657–668.
42. Comín-Colet J, Enjuanes C, Lupón J, Cainzos-Achirica M, Badosa N, Verdú JM. Transitions of care between acute and chronic heart failure: critical steps in the design of a multidisciplinary care model for the prevention of rehospitalization. *Rev Esp Cardiol.* 2016;69:951–961.
43. Anguita Sánchez M, Lambert Rodríguez JL, Bover Freire R, et al. Classification and quality standards of heart failure units: scientific consensus of the Spanish Society of Cardiology. *Rev Esp Cardiol.* 2016;69:940–950.