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SHORT COMMUNICATION

Impact of a 'stent for life' initiative on post-ST elevation myocardial infarction heart failure: a 15 year heart failure clinic experience

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Abstract

Aims Multidisciplinary heart failure (HF) clinics are a cornerstone of contemporary HF management. The stent-for-life (SFL) initiative improves mortality after ST elevation myocardial infarction (STEMI), but its impact in post-STEMI HF is not well characterized. Here we assessed the impact of SFL among patients referred to a multidisciplinary HF clinic over a 15 year time period.

Methods and results Between 2001 and 2015, 1921 patients were admitted to our HF clinic. In 2009, Catalonia established the Codi IAM network, a regional STEMI network that prioritizes primary percutaneous coronary intervention in STEMI. Patients admitted during the study period were divided into two groups based on admission date: pre-SFL (2001–June 2009; n = 1031) and post-SFL (July 2009–2015; n = 890). Compared with those in the pre-SFL group, patients admitted in the post-SFL period had better New York Heart Association (NYHA) functional class (22.1 vs. 38.7 NYHA classes III–IV; $P < 0.001$) and higher left ventricular ejection fraction (LVEF) (36.1 ± 19.6 vs. 32.6 ± 13.4; $P < 0.001$). Among STEMI survivors, 101 (6.7%) pre-SFL patients and 40 (2%) post-SFL patients ($P < 0.001$) fulfilled the criteria for HF clinic referral (Killip–Kimball class ≥ 2 during index admission and/or LVEF of $<40\%$). Furthermore, among patients admitted to the HF clinic, post-STEMI HF with reduced ejection fraction patients comprised 8.9% of the pre-SFL group and only 4.2% of the post-SFL group ($P < 0.001$).

Conclusions Among patients treated at our multidisciplinary HF clinic, the adoption of an SFL network has decreased the prevalence of post-STEMI HF with reduced ejection fraction.

Keywords Stent for life; ST elevation myocardial infarction; Heart failure clinics; Left ventricular ejection fraction; HF with reduced ejection fraction; New York Heart Association

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Introduction

Contemporary management of heart failure (HF) includes multidisciplinary structured follow-up programmes that provide patient education, medical treatment optimization, psychosocial support, and improved access to care.[1] Such strategies are designed to improve outcomes and reportedly reduce HF-related hospitalization and mortality following hospital discharge.[2] Heart failure programme implementation necessitates close collaboration between HF practitioners (primarily cardiologists, HF nurses, and general practitioners) and other experts, including pharmacists, dieticians, physiotherapists, psychologists, palliative care providers, and social workers.[1] Our institution established a multidisciplinary HF clinic in 2001.[3,4]

The prognosis of patients with HF has been profoundly impacted by advances in drug therapy, devices, and coronary revascularization—particularly the advent of primary percutaneous coronary intervention (p-PCI).[1] The stent-for-life (SFL) initiative is a unique European platform that encourages cooperation between interventional cardiologists, government representatives, industry partners, patient groups, and

patients to help shape healthcare systems and medical practices, with the aim of ensuring equal access to life-saving treatment with p-PCI for the majority of ST elevation myocardial infarction (STEMI) patients (http://www.stentforlife.com/). The SFL initiative began in Catalonia in 2009 as the Codi IAM network, which coordinates STEMI treatment among hospitals with various levels of technology that are connected by an efficient ambulance service. The set-up of the Codi IAM network, including the territorial organization and available resources, has been previously described.[5,6]

Our institute is a tertiary university hospital that has the only critical cardiovascular care unit (CCCU) within a well-defined geographical area covering ~850 000 inhabitants in the northern Barcelona Metro Area. In our present study, we analysed the impact of the SFL initiative, by comparing clinical characteristics of patients referred to our multidisciplinary HF clinic during two time periods: pre-SFL (2001–June 2009) and post-SFL (July 2009–2015).

Patients and methods

For this study, we considered all consecutive ambulatory patients referred to the structured multidisciplinary HF clinic of our university hospital between August 2001 and December 2015. Criteria for referral to the HF clinic (unchanged over the 15 year period) included HF with at least one hospitalization and/or reduced left ventricular ejection fraction (LVEF) of <40% and that have previously been described in detail.[3,4] Most patients were referred from cardiology and internal medicine departments, with smaller proportions from the emergency room/short-stay unit or other hospital departments. All patients were seen regularly during follow-up visits at the HF clinic, according to their needs.

This study was performed in compliance with laws protecting personal data and with the international guidelines for clinical investigation from the World Medical Association's Declaration of Helsinki.

Statistical analysis

Categorical variables are expressed as percentages. Distribution normality was assessed with normal Q-to-Q plots. Continuous variables with normal distributions were expressed as mean (standard deviation), and those with non-normal distributions as median (quartiles Q1–Q3). Differences between the two study groups were assessed using the χ^2 test, Student's *t*-test, Mann–Whitney U test, and Kruskal–Wallis test. Statistical analyses were performed using SPSS 15 (SPSS, Inc., Chicago, IL). A two-sided *P* value of <0.05 was considered significant.

Results

From August 2001 to December 2015, 1921 patients were admitted to our HF clinic: 1031 pre-SFL and 890 post-SFL. Patients of both periods showed similar clinical characteristics, including age (66.7 ± 12 vs. 66.9 ± 13 years; $P = 0.72$), sex (71.3% vs. 70.2% men; $P = 0.61$), and body mass index (27.5 ± 5.3 vs. 27.5 ± 5.5 kg/m^2; $P = 0.95$).

Compared with HF clinic attendees in the pre-SFL group, those admitted during the post-SFL period tended to show a shorter HF duration [6 (2–38) vs. 12 (1–48) months; $P = 0.1$], less often had history of previous myocardial infarction (31.8% vs. 48.3%; $P < 0.001$), showed a better New York Heart Association (NYHA) functional class (22.1 vs. 38.7 NYHA classes III–IV; $P < 0.001$), and had higher LVEF (36.1 ± 19.6 vs. 32.6 ± 13.4; $P < 0.001$) (*Table 1*). The improved LVEF was not due to patients referred to the HF clinic owing to STEMI (LVEF 31.4 ± 7.1 vs. 31.7 ± 7; $P = 0.79$) but rather to the lower number of such patients (see below) and the increase of patients with other HF aetiologies, such as dilated cardiomyopathy (151 vs. 99) and hypertrophic cardiomyopathy (15 vs. none). *Table S1* provides STEMI patients' characteristics in both study periods.

Applying the 2016 European Society of Cardiology classification of HF, we found that the post-SFL group showed a reduced proportion of patients with HF with reduced ejection fraction (HFrEF) and increased proportions of patients with HF with mid-range or preserved ejection fraction (HFmrEF or HFpEF, respectively) (*P* for trend of 0.01). In a multivariable logistic regression analysis with HFrEF as the dependent variable and significant clinical and treatment confounding factors [age, sex, previous myocardial infarction, hypertension, ischaemic aetiology, NYHA functional classes III–IV, HF duration, atrial fibrillation/flutter, treatment with implantable cardiac defibrillator, cardiac resynchronization therapy, beta-blockers, angiotensin-converting enzyme inhibitor/angiotensin II receptor blocker, ivabradine, and mineralocorticoid receptor antagonist, and study period (pre-SFL and post-SFL)], we observed that post-SFL period remained significantly associated with a lower prevalence of HFrEF patients [odds ratio 0.68 (95% confidence interval 0.54–0.87), $P < 0.001$].

Regarding aetiology, patients in the post-SFL period were less commonly referred with HF of ischaemic origin (55.6% vs. 44%; $P < 0.001$).

Regarding the impact of the SFL initiative, there were 3545 STEMI CCCU admissions during the 15 year period. *Table S1* shows clinical data of these CCCU patients in both study periods. Among 1516 pre-SFL admissions, 516 (34%) were treated with p-PCI (performed only during office hours). Among 2029 post-SFL admissions, 1838 (91%) were treated with p-PCI (performed 24/7). Among STEMI survivors, 101 (6.7%) pre-SFL patients and 40 (2%) post-SFL patients fulfilled the predefined criteria for referral to the HF clinic (Killip–Kimball class ≥ 2 during index admission and/or LVEF of <40%), showing a highly significant reduction between

Table 1 Baseline clinical characteristics of patients

	Pre-SFL $N = 1031$	Post-SFL $N = 890$	P value	$N = 1921$
Age, years	66.7 ± 12.1	66.9 ± 13.3	0.72	1921
Male	735 (71.3)	625 (70.2)	0.89	1921
White	1015 (99.4)	881 (99)	0.35	1921
HF duration, months	12 (1–48)	6 (2–38)	0.16	1921
LVEF[a], %	32.6 ± 13.4	36.1 ± 19.6	<0.001	1921
ESC HF classification			0.01	1921
HFrEF	786 (76.2)	617 (66.4)		
HFmrEF	127 (12.3)	137 (15.4)		
HFpEF	118 (11.4)	136 (15.3)		
Ischaemic aetiology	573 (55.6)	392 (44)	<0.001	
NYHA class III–IV	399 (38.7)	197 (22.1)	<0.001	1921
Previous AMI	498 (48.3)	283 (31.8)	<0.001	1921
Diabetes	418 (40.5)	393 (44.2)	0.11	1921
Hypertension	615 (59.7)	604 (67.9)	<0.001	1921
Anaemia[b]	447 (46.6)	397 (44.6)	0.62	1859
Renal insufficiency[c]	423 (41)	406 (45.6)	0.01	1900
Atrial fibrillation/flutter	206 (20)	225 (25.3)	0.005	1921
LBBB	138 (13.4)	105 (11.8)	0.30	1921
Heart rate	73.5 ± 14.7	69.6 ± 14.6	<0.001	1921
Blood pressure	126.3 ± 46.5	130 ± 34.5	0.05	1921
BMI, kg/m^2	27.5 ± 5.3	27.5 ± 5.5	0.95	1904
Treatment				1921
ACEI/ARB	806 (78.2)	610 (68.5)	<0.001	
Beta-blockers	647 (62.8)	706 (79.3)	<0.001	
MRA	264 (25.6)	375 (42.1)	<0.001	
Loop diuretics	788 (76.4)	702 (78.9)	0.20	
Digoxin	273 (26.5)	183 (20.6)	0.002	
Ivabradine	1 (0.1)	103 (11.6)	<0.001	
CRT	13 (1.3)	44 (4.9)	<0.001	
ICD	46 (4.5)	80 (9)	<0.001	

ACEI, angiotensin-converting enzyme inhibitor; AMI, acute myocardial infarction; ARB, angiotensin II receptor blocker; BMI, body mass index; CRT, cardiac resynchronization therapy; ESC, European Society of Cardiology; HF, heart failure; HFmrEF, heart failure with mid-range ejection fraction; HFpEF, heart failure with preserved ejection fraction; HFrEF, heart failure with reduced ejection fraction; ICD, implantable cardiac defibrillator; LBBB, left bundle branch block; LVEF, left ventricular ejection fraction; MRA, mineralocorticoid receptor antagonist; NYHA, New York Heart Association; SFL, stent for life.
[a]Assessed in almost all patients with two-dimensional echocardiography by Simpson's method.
[b]Haemoglobin < 12 g/dL in women and <13 g/dL in men.
[c]Estimated glomerular renal filtration (Chronic Kidney Disease Epidemiology Collaboration equation) < 60 mL/min/1.73 m^2.

the two studied periods ($P < 0.001$). Furthermore, among patients admitted to the HF clinic, STEMI patients comprised 9.8% of the pre-SFL group and 4.5% of the post-SFL group ($P < 0.001$) (*Figure 1*), and post-STEMI HFrEF patients comprised 8.9% of the pre-SFL group and 4.2% of the post-SFL group ($P < 0.001$). In point of fact, irrespective of the STEMI revascularization procedure, a similar LVEF was found in both study periods (31.6 ± 7.5 vs. 31.6 ± 6.6; $P = 0.97$). Indeed, the key message is the lower number of such patients in the SFL period, with fewer patients fulfilling the derivation criteria.

Treatment differences in patients referred to the HF clinic relative to study period were mainly mineralocorticoid receptor antagonists, much more used in the second period (*Table S2*).

Discussion

The SFL initiative has profoundly impacted the development of regional STEMI networks across Europe.[7] In Catalonia, the Codi IAM network was launched in 2009 and has already notably reduced STEMI-driven mortality.[6] Early reperfusion also has the potential to salvage viable myocardium and reduce STEMI-derived HF. Herein, we report a highly significant ~70% reduction in the number of STEMI patients with HF requiring care at an HF clinic based on well-defined referral criteria.

The present data have clinical implications. First, implementation of the SFL Codi IAM network has led to a lower frequency of HFrEF of ischaemic origin due to STEMI. During the post-SFL period, only 4.2% of patients attending our HF clinic had post-STEMI HFrEF, and this population comprised 2% of all STEMI cases fulfilling the criteria for HF clinic referral. The classical quote 'time is myocardium' remains pertinent to reducing STEMI mortality and morbidity. Second, we identified a trend towards increasing prevalences of patients with HFmrEF and HFpEF. In essence, HFmrEF largely resembles HFpEF with the key exceptional characteristic of involving ischaemia, as in HFrEF.[8] Larger prospective randomized clinical trials in HFmrEF are required to better understand its pathophysiology and therapeutic needs. Third,

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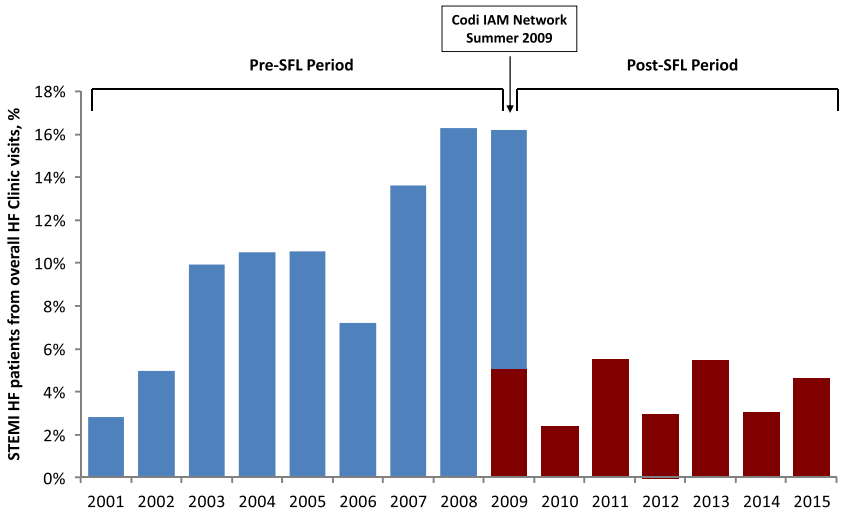
Figure 1 Yearly distribution of post-ST elevation myocardial infarction (STEMI) patients with heart failure (HF) who attended our HF clinic over 15 years. Note the dramatic reduction in the number of patients after implementation of the stent-for-life (SFL) Codi IAM network.



since activation of the SFL Codi IAM network, substantially more STEMI patients have attended a Codi IAM 24/7 hospital. However, the majority is Killip–Kimball class < 2 and does not require follow-up at a dedicated multidisciplinary HF clinic.[6] Rehabilitation clinics may be more appropriate for this patient subgroup. Furthermore, the SFL Codi IAM network has successfully reduced STEMI-related mortality and morbidity to date; it is important to remain vigilant and continue active public awareness campaigns.[9]

We acknowledge that our present study has several limitations. Owing to its observational, retrospective, and single-centre nature, this report cannot provide a comprehensive overview of the magnitude of HF after STEMI. Rather, it reflects our experience in a real-life multidisciplinary HF clinic over a 15 year period during which clinical pathways and referral geographical areas have remained stable. Moreover, it is beyond the scope of this study to characterize all factors that could have potentially impacted HF over the past 15 years. We previously reported in detail the characteristics of the Codi IAM network[6] and of our HF clinic.[3,4] The aim of our present report was to study both initiatives, to illustrate the changing face of HF in the 21st century. The temporal bias and the importance of different techniques in different timelines during the study period should also be taken into consideration.

In conclusion, fewer patients with post-STEMI HFrEF have been referred to our multidisciplinary HF clinic since the adoption of an SFL network in Catalonia. Notably, STEMI HFrEF accounted for 8.9% of patients admitted during the pre-SFL period and only 4.2% in the post-SFL period. Further comprehensive studies are needed to determine whether circa post-STEMI HFrEF is declining from HF clinics as a result of the SFL initiative, as seems to be the case in our HF clinic.

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Conflict of interest

None declared.

Author Contributions

Antoni Bayes-Genis: study design, manuscript draft, statistical analysis, and final review of the manuscript.

Cosme García: data collection from STEMI and critical review of the manuscript.

Marta de Antonio: data collection from the HF clinic and critical review of the manuscript.

Eduard Fernandez-Nofrerías: data collection from STEMI and critical review of the manuscript.

Mar Domingo: data collection from the HF clinic and critical review of the manuscript.

Elisabet Zamora: data collection from the HF clinic and critical review of the manuscript.

Pedro Moliner: data collection from the HF clinic and critical review of the manuscript.

Josep Lupón: data collection from the HF clinic, statistical analysis, and critical review of the manuscript.

Supporting information

Additional Supporting Information may be found online in the supporting information tab for this article.

Table S1. Data of STEMI patients admitted to the CCCU in both study periods.

Table S2. Baseline treatments in patients sent to the unit after an acute STEMI.

References

1. Ponikowski P, Voors AA, Anker SD, Bueno H, Cleland JG, Coats AJ, Falk V, González-Juanatey JR, Harjola VP, Jankowska EA, Jessup M, Linde C, Nihoyannopoulos P, Parissis JT, Pieske B, Riley JP, Rosano GM, Ruilope LM, Ruschitzka F, Rutten FH, van der Meer P, Authors/Task Force Members. 2016 ESC guidelines for the diagnosis and treatment of acute and chronic heart failure: the Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC) developed with the special contribution of the Heart Failure Association (HFA) of the ESC. *Eur Heart J* 2016; **37**: 2129–2200.
2. Feltner C, Jones CD, Cené CW, Zheng ZJ, Sueta CA, Coker-Schwimmer EJ, Arvanitis M, Lohr KN, Middleton JC, Jonas DE. Transitional care interventions to prevent readmissions for persons with heart failure: a systematic review and meta-analysis. *Ann Intern Med* 2014; **160**: 774–784.
3. Zamora E, Lupón J, Vila J, Urrutia A, de Antonio M, Sanz H, Grau M, Ara J, Bayés-Genís A. Estimated glomerular filtration rate and prognosis in heart failure: value of the MDRD-4, CDK-EPI, and Cockroft–Gault formulas. *J Am Coll Cardiol* 2012; **59**: 1709–1715.
4. Gastelurrutia P, Lupón J, de Antonio M, Urrutia A, Díez C, Coll R, Altimir S, Bayes-Genis A. Statins in heart failure: the paradox between large randomized clinical trials and real life. *Mayo Clin Proc* 2012; **87**: 555–560.
5. Bosch X, Curós A, Argimon JM, Faixedas M, Figueras J, Jiménez-Fàbrega FX, Masià R, Mauri J, Tresserras R. Model of primary percutaneous intervention in Catalonia. *Rev Esp Cardiol* 2011; **11**(Suppl. C): 51–60.
6. Carrillo X, Fernandez-Nofrerias E, Rodriguez-Leor O, Oliveras T, Serra J, Mauri J, Curos A, Rueda F, García-García C, Tresserras R, Rosas A, Faixedas MT, Bayes-Genis A, Codi IAM Investigators. Early ST elevation myocardial infarction in non-capable percutaneous coronary intervention centres: in situ fibrinolysis vs. percutaneous coronary intervention transfer. *Eur Heart J* 2016; **37**: 1034–1040.
7. Kristensen SD, Laut KG, Fajadet J, Kaifoszova Z, Kala P, Di Mario C, Wijns W, Clemmensen P, Agladze V, Antoniades L, Alhabib KF, De Boer MJ, Claeys MJ, Deleanu D, Dudek D, Erglis A, Gilard M, Goktekin O, Guagliumi G, Gudnason T, Hansen KW, Huber K, James S, Janota T, Jennings S, Kajander O, Kanakakis J, Karamfiloff KK, Kedev S, Kornowski R, Ludman PF, Merkely B, Milicic D, Najafov R, Nicolini FA, Noč M, Ostojic M, Pereira H, Radovanovic D, Sabaté M, Sobhy M, Sokolov M, Studencan M, Terzic I, Wahler S, Widimsky P, European Association for Percutaneous Cardiovascular Interventions. Reperfusion therapy for ST elevation acute myocardial infarction 2010/2011: current status in 37 ESC countries. *Eur Heart J* 2014; **35**: 1957–1970.
8. Lam CS, Teng TH. Understanding heart failure with mid-range ejection fraction. *JACC Heart Fail* 2016; **4**: 473–476.
9. Regueiro A, Rosas A, Kaifoszova Z, Faixedas MT, Curos A, Tresserras R, Sabaté M. Impact of the 'ACT NOW. SAVE A LIFE' public awareness campaign on the performance of a European STEMI network. *Int J Cardiol* 2015; **197**: 110–112.