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ARTYKUŁ ORYGINALNY / *ORIGINAL ARTICLE*

Heart failure patients with a previous coronary revascularisation: results from the ESC-HF registry

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Abstract

Background: Coronary revascularisation is common in heart failure (HF).

Aim: Clinical characteristic and assessment of in-hospital and long-term outcomes in patients hospitalised for HF with or without a previous percutaneous coronary intervention (PCI) or a coronary artery bypass grafting (CABG).

Methods: The primary endpoint (PE) (all-cause death) and the secondary endpoint (SE) (all-cause death or hospitalisation for HF-worsening) were assessed at one year in 649 inpatients of the ESC-HF Pilot Survey. Additionally, occurrence of death during index hospitalisation was evaluated.

Results: PCI/CABG-patients (32.7%) were more frequently male, smokers, and had myocardial infarction, hypertension, peripheral artery disease, and diabetes. The non-PCI/CABG-patients more often had cardiogenic shock and died in-hospital. The PE occurred in 33 of the 212 PCI/CABG-patients (15.6%) and in 56 of the 437 non-PCI/CABG-patients (12.8%; p = 0.3). The SE occurred in 82 of the 170 PCI/CABG-patients (48.2%) and in 122 of the 346 non-PCI/CABG-patients (35.3%; p = 0.01). Independent predictors of the PE in the PCI/CABG-patients were: lower left ventricular ejection fraction and use of antiplatelets; in the non-PCI/CABG-patients were: age and acute coronary syndrome at admission. Independent predictors of SE in the PCI/CABG-patients were: diabetes, New York Heart Association (NYHA) class at admission, and hypertension; in the non-PCI/CABG-patients they were: NYHA class and haemoglobin at admission. Serum sodium concentration at admission was a predictor of PE and SE in both groups. Heart rate at discharge was a predictor of PE and SE in the non-PCI/CABG patients.

Conclusions: The revascularised HF patients had a similar mortality and higher risk of death or hospitalisation at 12 months compared with the non-PCI/CABG-patients. The revascularised patients had more comorbidities, while the non-PCI/CABG-patients had a higher incidence of cardiogenic shock and in-hospital mortality.

Key words: heart failure, hospitalisation, prognosis, registry, revascularisation

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INTRODUCTION

Heart failure (HF) is an increasingly common disease [1]. The chronic nature of HF is associated with poor outcomes, high healthcare costs, as well as being a leading cause of hospitalisation [1, 2]. Among the various causes of HF, ischaemic aetiology represents the majority, with incidence ranging between 30% and 57% [1–6]. This is firstly related to ageing modern societies developing left ventricular (LV) dysfunction as a manifestation of chronic coronary artery disease (CAD) [1–5], and secondly to improved survival of patients after acute myocardial infarction (MI) [1, 7].

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Coronary artery disease is a major contributor to mortality and morbidity in HF patients [6–8]. Over the last decade survival has significantly improved in HF patients who have undergone coronary revascularisation [7, 9]. Appropriate coronary revascularisation leads to improvement in quality of life in terms of freedom from angina, reduced angina frequency, improved measures of physical limitation, and treatment satisfaction in patients with MI and also in a stable CAD compared with only pharmacological therapy [7, 10, 11]. According to the AMI-PL database, about 80% of patients admitted with MI proceed with coronary revascularisation [12]. Improvement in CAD treatment with coronary artery by-pass grafting (CABG) or percutaneous coronary intervention (PCI) reduces in-hospital mortality but leads to an increased number of survivors with LV dysfunction [7, 10, 13]. Admission rates following HF hospitalisation remain high, especially after PCI, and pose a major economic problem for healthcare systems and patients themselves [1, 10]. In the AMI-PL database, in patients after MI, HF was the second most frequent cause of readmission during a one-year observation, (the first cause was stable CAD) [12].

In the AHEAD registry, approximately 30% of HF patients had a previous PCI or CABG [14], leaving a substantial group of patients for further investigation. Insight into clinical characteristics and factors related to worse prognosis may be a helpful component of comprehensive care of HF patients after coronary revascularisation.

The objective of the present study was to evaluate clinical characteristics, as well as in-hospital and long-term outcomes of patients hospitalised for HF with or without previous PCI or CABG. Prognostic factors of the long-term outcomes were also determined.

METHODS

Study population

The Polish part of the ESC-HF Pilot Survey registry was a multicentre, prospective observational study conducted in 29 centres from Poland [15]. The survey enrolled adults (i.e. over 18 years old) with HF seen in ambulatory care, as well as inpatients admitted for acute or chronic HF during one particular day per week from October 2009 to May 2010. Patients were followed for one year.

Data collected in the registry relates to baseline characteristics, clinical presentation, previous and current treatment, diagnostic tests results, clinical course of index hospitalisation (in the case of inpatients), and one-year follow-up. The Local Ethical Review Board approved the registry. All participating subjects were provided with detailed information, and all of them signed written consent.

The current study included Polish patients of the ESC-HF Pilot Registry, who were hospitalised for HF (new onset or worsening). The study excluded outpatients seen in outpatient care.

Study groups — comparative analysis

Patients were divided into two groups with regard to occurrence of coronary revascularisation. Patients with PCI or CABG before admission were named as "PCI/CABG". Patients with revascularisation during enrolment hospitalisation were not included into this group. In contrast, patients without previous revascularisation were named as "non-PCI/CABG".

We conducted a comparative analysis of the two groups. It included baseline characteristics, clinical status at hospital admission and at hospital discharge, in-hospital management of the patients, and pharmacotherapy. Patients were also compared with regard to in-hospital and one-year outcomes. Predictors of the one-year outcomes were evaluated.

Study endpoints

The primary endpoint was all-cause death at 12 months after hospital discharge. The secondary endpoint was a composite of all-cause death and hospital readmissions for HF worsening at 12 months' observation. Additionally, occurrence of death during index hospitalisation was evaluated.

Statistical analysis

All statistical analyses were performed using SAS software, version 9.2. (SAS Institute, United States). Normally distributed continuous variables were reported as mean and standard deviation. Ordinal variables and non-normally distributed continuous variables were shown as median (interquartile range [IQR]). All parameters in baseline characteristics were compared using Fisher's exact test for categorical variables and the Mann-Whitney U test for continuous and ordinal variables. Cox proportional hazards regression analysis was performed to determine the risk factors of the primary and the secondary endpoints. In order to maintain adequate events per predictor variable value, due to the relatively small size of the study groups, variables with data missing for more than 5% were excluded from the Cox proportional hazards regression analyses [16]. Kaplan-Meier curves for both groups were delineated to show the primary and the secondary endpoints. Statistical significance was considered for p values < 0.05 for all tests. All factors that were found to be statistically significant in univariate analyses were included into multivariate logistic regression analysis. All tests were two tailed.

RESULTS

Study group selection

Figure 1 shows the flow chart of patient enrolment in the study. A total of 5118 patients were enrolled in the ESC-HF Pilot across Europe. In the Polish cohort of the registry, there were 893 participants, including 650 inpatients. For the final analysis, there were 649 patients hospitalised for HF (one patient with missing data on prior revascularisation was excluded).

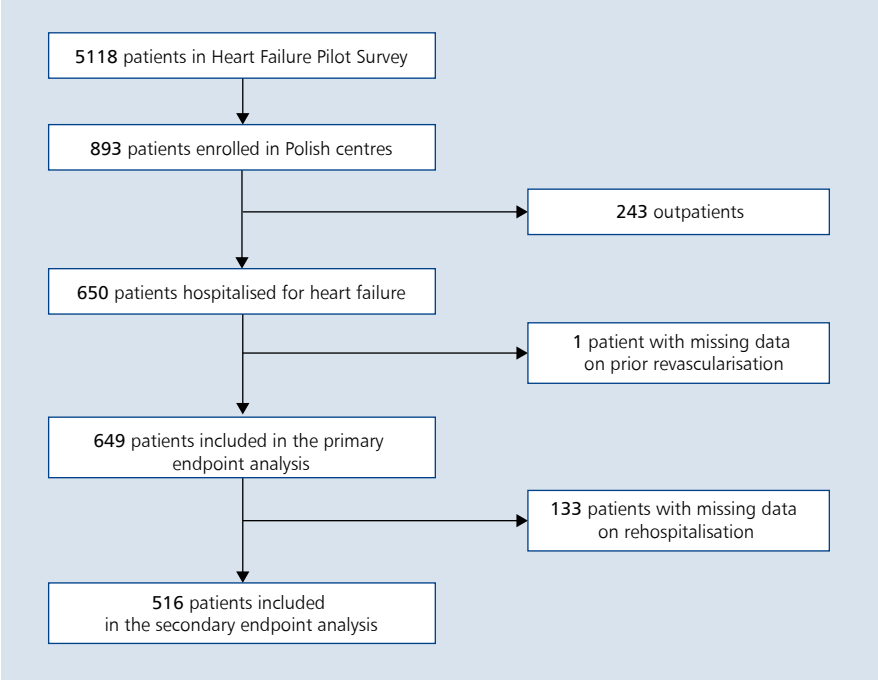

Figure 1. Flow chart of patient enrolment in the current analysis

Study group characteristics

The history of prior PCI/CABG had 212 of the 649 patients (32.7%). Patients' demographics, medical history, clinical course of index hospitalisation, management and diagnostic tests performed during hospitalisation, as well as in-hospital and one-year outcomes, are summarised in Tables 1–3.

Primary endpoint

Data on one-year survival were available for the entire study group (649 patients). The primary endpoint occurred in 89 of the 649 patients (13.7%), including 33 of the 212 PCI/CABG group (15.6%) and in 56 of the 437 non-PCI/CABG group (12.8%; p = 0.3), as shown in Table 3. Kaplan-Meier curves for the primary endpoint in both groups are plotted in Figure 2. Univariate analyses of the prognostic factors of the primary endpoint are presented in the **supplementary material**, respectively, for the PCI/CABG group in **Table S1 (see journal website)** and for the non-PCI/CABG group in **Table S2 (see journal website)**. All variables shown to be predictive of the primary endpoint in univariate analyses were consequently included in multivariate models, as presented in Table 4.

Secondary endpoint

The data on hospital readmission at 12 months were available for 516 patients (79.5% of 649 patients). The secondary endpoint occurred in 82 of the 170 PCI/CABG patients (48.2%) and in 122 of the 346 non-PCI/CABG patients (35.3%; p = 0.01), as shown in Table 3. Kaplan-Meier curves for the secondary endpoint in both groups are plotted in Figure 3. All variables predictive of the secondary endpoint in univariate analyses were consequently included in multivariate models, as presented in Table 4.

One-year outcomes in patients with CAD with or without previous PCI or CABG

Additionally, we performed also a sub-analysis including only patients with CAD. Data on one-year survival were available for the entire population with CAD (393 patients). The primary endpoint occurred in 63 of the 393 patients (16%), including 29 of the 199 PCI/CABG group (14.6%) and 34 of the 194 non-PCI/CABG group (17.5%; p = 0.5), The data on hospital readmission at 12 months were available for 328 patients (83.5% of 393 patients). The secondary endpoint occurred in 137 of the 328 patients (41.8%), including 77 of the 159 PCI/CABG patients (48.4%) and 60 of the 169 non-PCI/CABG patients (35.5%; p = 0.02).

DISCUSSION

The HF Pilot Survey of the European Society of Cardiology (ESC) was a multicentre registry of HF patients across Europe [15]. In our previous publication of results of the ESC-HF Pilot registry on Polish hospitalised patients we showed that a history of previous PCI or CABG was an independent risk factor of combined endpoint of death or hospitalisation [17]. Coronary revascularisation is one of the key management considerations in patients with HF, besides pharmacological treatment and electrophysiological implantable devices [7]. In this study, we compared the clinical characteristics and

Table 1. Baseline clinical characteristics and previous pharmacotherapy in patients with or without previous coronary revascularisation

Variable	Data on previous revascularisation (n = 649)		p
	PCI/CABG (n = 212)	Non-PCI/CABG (n = 437)	
Demographics			
Age [years]	68 (58–76); n = 212	70 (58–78); n = 437	0.3
Male	75.0%; 159/212	59.3%; 259/437	< 0.0001
Body mass index [kg/m^2]	27.7 (24.7–31.2); n = 190	27.7 (24.6–31.2); n = 381	1.0
Heart failure			
LVEF [%]	32 (25–42); n = 179	39 (29–50); n = 388	< 0.0001
Ischaemic aetiology	93.9%; 199/212	44.4%; 194/437	< 0.0001
Hypertensive aetiology	0.5%; 1/212	15.6%; 68/437	< 0.0001
Valvular aetiology	3.3%; 7/212	15.6%; 68/437	< 0.0001
HFrEF	86.0%; 154/179	69.9%; 271/388	< 0.0001
Previous HF hospitalisation	64.6%; 137/212	54.0%; 237/437	0.01
Medical history			
Hypertension	72.6%; 154/212	62.7%; 274/437	0.01
Myocardial infarction	94.8%; 201/212	41.4%; 181/437	< 0.0001
Peripheral artery disease	15.6%; 33/212	5.5%; 24/437	< 0.0001
Atrial fibrillation	37.7%; 80/212	39.6%; 172/434	0.7
Diabetes	43.9%; 93/212	31.4%; 137/437	0.002
Chronic kidney disease	25.5%; 54/212	21.7%; 95/437	0.3
COPD	11.3%; 24/212	13.3%; 58/436	0.5
Stroke	12.3%; 26/212	9.2%; 40/436	0.3
Current smoking	63.6%; 129/203	54.2%; 228/421	0.03
Previous pharmacotherapy			
Diuretics	72.6%; 148/204	57.1%; 234/410	< 0.0001
Aldosterone antagonist	51.2%; 104/203	37.1%; 151/407	< 0.0001
ACEI	74.9%; 152/203	55.5%; 226/407	< 0.0001
ARB	5.9%; 12/203	8.9%; 36/404	0.3
Beta-blocker	84.7%; 172/203	65.6%; 267/407	< 0.0001
Statin	79.9%; 163/204	39.4%; 160/406	< 0.0001
Anticoagulants	26.3%; 54/205	27.6%; 112/406	0.8
Antiplatelets	76.1%; 156/205	41.9%; 168/405	< 0.0001

In each bar the total number (n) of patients for whom a given variable was available in the registry is shown. Continuous and ordinal variables are shown as a median/mean value and interquartile range/standard deviation. A p value of < 0.05 is considered statistically significant. Conversion factors to SI units are as follows: creatinine — 88.4, haemoglobin — 0.6206; ACEI — angiotensin-converting-enzyme inhibitor; ARB — angiotensin receptor blocker; CABG — coronary artery bypass grafting; COPD — chronic obstructive pulmonary disease; HF — heart failure; HFrEF — heart failure with reduced ejection fraction; LVEF — left ventricular ejection fraction; PCI — percutaneous coronary intervention

prognostic factors in patients with and without previous revascularisation. We also performed a sub-analysis aiming to compare one-year outcomes of HF patients with confirmed CAD with or without previous coronary revascularisation. Our objective was not to determine differences in survival based upon the revascularisation strategy (CABG or PCI).

The prevalence of an ischaemic aetiology of HF in our study is higher (60.6%) than in other registries (ADHERE — 57%, ATTEND — 33%, EHFS-II — 30%, OPTIMIZE-HF — 46%) [3–6]. In our analysis 33% of HF patients had prior PCI or CABG in their medical history, while in AHEAD registry 29.5% of HF patients had previously performed PCI or CABG [14].

The high proportion of males and CAD in the PCI/CABG group increased the frequency of other comorbidities [18]. Present analysis demonstrated that the PCI/CABG patients

Table 2. Clinical and laboratory status at hospital admission for patients with or without previous coronary revascularisation

Variable	Data on previous revascularisation (n = 649)		p
	PCI/CABG (n = 212)	Non-PCI/CABG (n = 437)	
Clinical status at admission			
Cardiogenic shock	0.5%; 1/186	3.7%; 15/404	0.03
NYHA class	3 (2–3); n = 210	3 (2–4); n = 435	0.2
SBP [mm Hg]	130 (110–147); n = 211	130 (120–150); n = 435	0.05
Heart rate [bmp]	80 (70–92); n = 210	80 (70–100); n = 436	0.003
VF or VT as a cause of admission	6.6%; 14/212	3.7%; 16/434	0.1
ACS as a cause of admission	34.9%; 74/212	27.1%; 118/435	0.04
AF as a cause of admission	11.4%; 24/211	16.8%; 71/424	0.08
Laboratory findings at admission			
Serum sodium [mmol/L]	138 (136–141); n = 211	138.8 (136–141); n = 429	1.0
Serum potassium [mmol/L]	4.4 (4.1–4.7); n = 210	4.4 (4–4.8); n = 429	0.7
Serum creatinine [mg/dL]	1.10 (0.93–1.40); n = 206	1.09 (0.90–1.40); n = 412	0.2
Haemoglobin [g/dL]	13.2 (12.1–14.7); n = 208	13.3 (12.0–14.4); n = 426	0.6

In each bar the total number (n) of patients for whom a given variable was available in the registry is shown. Continuous and ordinal variables are shown as a median/mean value and interquartile range/standard deviation. A *P* value of < 0.05 is considered statistically significant. Conversion factors to SI units are as follows: creatinine — 88.4, haemoglobin — 0.6206; ACS — acute coronary syndrome; AF — atrial fibrillation; CABG — coronary artery bypass grafting; NYHA — New York Heart Association; PCI — percutaneous coronary intervention; SBP — systolic blood pressure; VF — ventricular fibrillation; VT — ventricular tachycardia

Table 3. Management during index hospitalisation, clinical status, and pharmacotherapy at discharge, as well as in-hospital and one-year outcomes of patients with or without previous coronary revascularisation

Variable	Data on previous revascularisation (n = 649)		p
	PCI/CABG (n = 212)	Non-PCI/CABG (n = 437)	
Major management during index hospitalisation, clinical status at discharge			
PCI/CABG during hospitalisation	28.0%; 44/212	9.6%; 42/437	< 0.0001
ICD implantation during hospitalisation	12.3%; 26/212	2.8%; 12/437	< 0.0001
Heart rate [bpm]	72 (65–80); n = 204	75 (68–87); n = 418	0.01
SBP [mm Hg]	120 (110–130); n = 208	120 (110–130); n = 419	0.5
Pharmacotherapy at hospital discharge*			
Diuretics	86.7%; 182/210	84.7%; 355/419	0.2
Aldosterone antagonist	68.0%; 143/210	64.6%; 271/419	0.3
ACEI	77.1%; 162/210	76.1%; 319/419	0.4
ARB	9.0%; 19/210	8.7%; 36/413	0.8
Beta-blocker	93.3%; 196/210	84.7%; 355/419	0.01
Statin	84.8%; 178/210	64.4%; 270/419	< 0.0001
Anticoagulants	37.6%; 79/210	41.7%; 175/419	0.6
Antiplatelets	86.2%; 181/210	63.0%; 264/419	< 0.0001
In-hospital outcome			
Hospitalisation length [days]	7 (4–11); n = 212	7 (4–11); n = 437	0.4
Death during hospitalisation	0.9%; 2/212	4.1%; 18/437	0.03
One-year outcome			
Death	15.6%; 33/212	12.8%; 56/437	0.3
Death or hospitalisation	48.2%; 82/170	35.3%; 122/346	0.01

*In patients who survived to hospital discharge. In each bar the total number (n) of patients for whom a given variable was available in the registry is shown. Continuous and ordinal variables are shown as a median/mean value and interquartile range/standard deviation. A p value of < 0.05 is considered statistically significant. Conversion factors to SI units are as follows: creatinine — 88.4, haemoglobin — 0.6206; ACEI — angiotensin-converting-enzyme inhibitor; ARB — angiotensin receptor blocker; CABG — coronary artery bypass grafting; ICD — implantable cardioverter defibrillator; PCI — percutaneous coronary intervention; SBP — systolic blood pressure

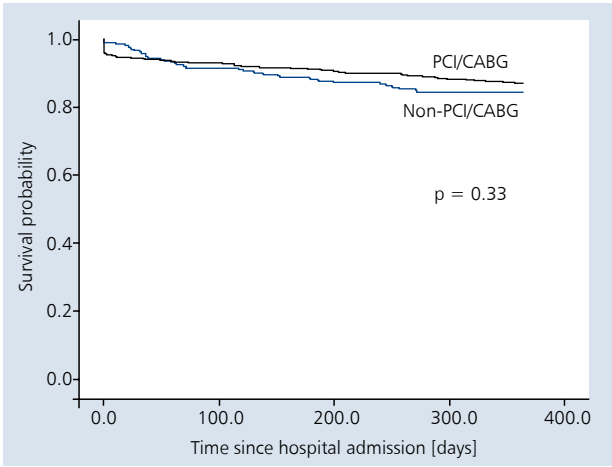

Figure 2. Kaplan-Meier curves for the primary endpoint in the PCI/CABG group and the non-PCI/CABG group; CABG — coronary artery bypass grafting; PCI — percutaneous coronary intervention

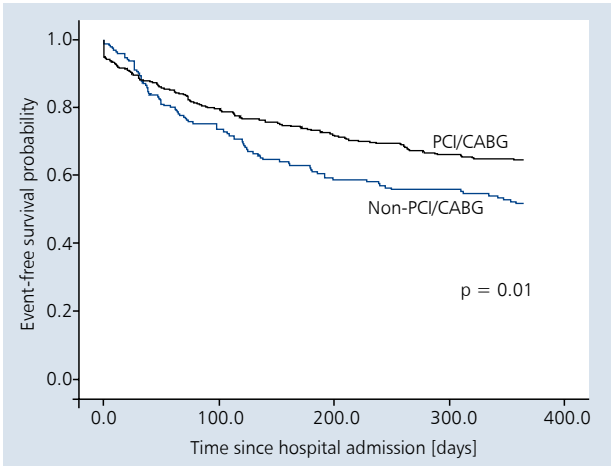

Figure 3. Kaplan-Meier curves for the secondary endpoint in the PCI/CABG group and the non-PCI/CABG group; CABG — coronary artery bypass grafting; PCI — percutaneous coronary intervention

Table 4. Multivariate analyses of the primary and the secondary endpoint in the PCI/CABG group and in the non-PCI/CABG group

	Primary endpoint		Secondary endpoint	
	HR (95% CI)	p	HR (95% CI)	p
PCI/CABG group				
History of hypertension	–	–	0.36 (0.22–0.61)	0.0001
History of diabetes	–	–	1.83 (1.15–2.93)	0.01
History of AF	1.80 (0.68–4.80)	0.2	1.53 (0.89–2.63)	0.1
Left ventricular ejection fraction [%]	0.95 (0.91–0.996)	0.03	–	–
NYHA class at admission, per 1 class	1.45 (0.72–2.90)	0.3	1.50 (1.06–2.12)	0.02
SBP at admission, per 10 mm Hg	0.99 (0.97–1.00)	0.1	–	–
Heart rate at admission, per 10 bpm	1.02 (0.998–1.03)	0.1	–	–
AF as a cause of admission	2.57 (0.71–9.34)	0.2	1.76 (0.88–3.53)	0.1
Serum sodium at admission, per 0.5 mmol/L	0.85 (0.76–0.95)	0.01	0.91 (0.85–0.97)	0.002
Serum potassium at admission, per 1 mmol/L	1.07 (0.51–2.27)	0.9	–	–
Serum creatinine at admission, per 1 mg/dL	1.65 (0.91–2.99)	0.1	1.16 (0.83–1.64)	0.4
ACEI treatment at discharge	–	–	0.75 (0.44–1.28)	0.3
Antiplatelet treatment at discharge	0.31 (0.11–0.86)	0.02	–	–
Anticoagulant treatment at discharge	–	–	1.12 (0.66–1.88)	0.7
Non-PCI/CABG group				
Age, per 10 years	1.05 (1.02–1.08)	0.001	–	–
History of myocardial infarction	1.20 (0.66–2.17)	0.5	–	–
History of diabetes	1.78 (0.99–3.20)	0.05	–	–
NYHA class at admission, per 1 class	1.37 (0.89–2.09)	0.2	1.43 (1.09–1.88)	0.01
SBP at admission, per 10 mm Hg	0.997 (0.99–1.01)	0.6	0.99 (0.99–1.00)	0.09
Heart rate at admission, per 10 bpm	1.00 (0.99–1.02)	0.6	–	–
Serum sodium at admission, per 0.5 mmol/L	0.89 (0.85–0.93)	< 0.0001	0.95 (0.91–0.99)	0.02
Haemoglobin at admission, per 1 g/dL increase	0.92 (0.79–1.07)	0.3	0.87 (0.79–0.96)	0.01
ACS as a cause of admission	2.07 (1.16–3.69)	0.01	–	–
Heart rate at discharge, per 10 bpm	1.03 (1.01–1.05)	0.0004	1.01 (1.00–1.02)	0.03
Beta-blocker treatment at discharge	0.66 (0.33–1.31)	0.2	–	–

ACEI — angiotensin-converting-enzyme inhibitor; ACS — acute coronary syndrome; AF — atrial fibrillation; CABG — coronary artery bypass grafting; CI — confidence interval; HR — hazard ratio; NYHA — New York Heart Association; PCI — percutaneous coronary intervention; SBP — systolic blood pressure

were more likely to have several risk factors and pre-existing diseases at baseline, including a history of MI, hypertension, peripheral artery disease, diabetes, and were more likely to smoke tobacco. Worse clinical condition potentially caused a higher rate of previous HF hospitalisations in those patients. As expected, due to a higher prevalence of CAD, the PCI/CABG patients more frequently had been prescribed antiplatelets, statins, and beta-blockers at the time of discharge.

Patients with prior coronary revascularisation had a lower left ventricular ejection fraction (LVEF), which could potentially explain the higher implantation rate of a cardioverter-defibrillator during hospitalisation. It also explains why those patients were more often treated with angiotensin converting enzyme inhibitors, aldosterone antagonists, and diuretics at the time of admission.

In comparison, the non-PCI/CABG group was characterised by a worse clinical status at hospital admission, which was manifested by a higher incidence of cardiogenic shock and higher in-hospital mortality. In the AMIS Plus Registry, investigators showed that increased rates of the PCI were associated with a decreased risk for development of cardiogenic shock [19].

One-year outcomes

Improved long-term prognosis in HF patients after coronary revascularisation was documented [10]. Favourable effects of coronary revascularisation are manifested by improvement in LVEF, New York Heart Association (NYHA) functional class, and protection against LV remodelling [20].

In our study, based on a real-life cohort of patients with HF, we observed similar mortality in one-year observation of HF patients with the prior revascularisation, compared to those without previous PCI or CABG. However, patients with documented revascularisation were at higher risk for death or hospitalisation (due to HF worsening) than the non-PCI/CABG patients. As with our study, in the EVEREST trial there was an observed increased risk of hospitalisations without associated increased risk of death [18]. The authors of the EVEREST trial evaluated the prognosis of HF patients with CAD, but they classified patients as having CAD based on the history of MI or coronary revascularisation [18].

Higher risk of hospitalisation likely depends on the overall disease burden. In the OPTIMIZE-HF registry, in a short-term observation (60 to 90 days) the mortality rate did not increase in patients with CAD, who underwent coronary revascularisation, compared to thosewithout CAD [6]. These data confirm that coronary revascularisation improves survival, but leaves a group of patients with impaired LV function and therefore with increased risk of HF worsening.

The STICH trial evaluated effectiveness of a pharmacotherapy alone versus the CABG in HF patients with LVEF < 35% and CAD [21]. In contrast to our study, the authors of the STICH trial excluded patients who were candidates for PCI. The investigators suggested that patients with poor exercise capacity have an increased risk of early death and similar five-year mortality after the CABG, compared to the pharmacotherapy alone. Whereas those with better exercise capacity have an improved survival after the CABG [21]. These results suggest that it is necessary to identify patients for whom revascularisation might be more beneficial.

Mortality from CAD has been reduced due to the effective reperfusion strategies in acute MI. However, this has led to an increase in the incidence of HF with reduced LVEF, which is referred to as ischaemic cardiomyopathy [13]. According to the ESC guidelines, approximately half of patients with HF have reduced LVEF, which is regarded as an independent risk factor for poor outcomes [8]. In our study, lower LVEF was an independent predictor of mortality in the PCI/CABG patients. It could be suspected that use of antiplatelets at hospital discharge had a protective value for the primary endpoint in those patients.

Interestingly, in our study hypertension had a protective value in the PCI/CABG patients. This result is also in line with the increased in-hospital mortality and frequent cardiogenic shock occurrence observed in the non-PCI/CABG patients. These results suggest that a higher blood pressure in HF patients may be advantageous in the long-term observation and speak against excessive antihypertensive therapy in HF patients.

Diabetes mellitus is one of the major risk factors for CAD and often leads to the need for coronary revascularisation. Moreover, compared to the non-PCI/CABG patients, diabetes was an independent risk factor of the secondary endpoint in the PCI/CABG group. This is the same as in the OPTIMIZE-HF study [6]. This may suggest that there is a need for intensive blood glucose control and intensive antidiabetic treatment after coronary revascularisation. However, in the ACCORD study, which recruited patients with type 2 diabetes mellitus and other cardiovascular risk factors, the intensive hypoglycaemic treatment with the goal of achieving normal HbA1c concentration was associated with an increase in mortality without significantly affecting the incidence of cardiovascular complications [22]. In our study, 30% of patients in the PCI/CABG group still required further revascularisation during index hospitalisation.

Due to the less frequent incidence of ischaemic HF in the non-PCI/CABG patients, attention should be paid towards other risk factors for unfavourable outcomes in this group. Anaemia in the HF population is associated with higher risk of death and hospitalisation [8]. Our study confirmed that lower haemoglobin concentration is an independent predictor of the secondary endpoint in the non-PCI/CABG patients. Also, a higher heart rate at discharge has previously been associated with greater mortality in HF patients [23]. In our study, this variable was found to be a significant risk factor of the primary and the secondary endpoint in the non-PCI/CABG

patients. This finding adds to the discussion about appropriate heart rate control in HF patients.

According to the ATTEND registry, patients aged ≥ 65 years, compared to patients aged < 65 years, are characterised by higher short- and long-term mortality after hospital discharge and they are at increased risk for hospital readmissions [24]. In our study, older age was associated with unfavourable outcomes in the non-PCI/CABG group, but not in patients with a previous history of PCI or CABG. The second predictor of the secondary endpoint in the non-PCI/CABG patients was acute coronary syndrome as a cause of admission. This may suggest a beneficial impact of previous revascularisation on prognosis of patients hospitalised with acute coronary syndrome.

In our previous study, we demonstrated that a higher NYHA functional class and hyponatraemia at hospital admission are significant predictors of one-year mortality in HF patients [17, 25]. In the present study, in both the PCI/CABG group and the non-PCI/CABG group, a NYHA functional class and hyponatraemia were independent predictors of the study endpoints. A higher NYHA functional class is closely related to advanced structural heart disease, manifested by severe symptoms of HF at rest or upon minimal exercise, despite intensive treatment being introduced [7, 8], whereas hyponatraemia is mostly caused by increased secretion of arginine vasopressin due to a low cardiac output and it is frequently aggravated by loop diuretics [25].

Our findings show that HF patients with previous coronary revascularisation remain at higher risk of death and hospitalisation, which also reflects their burden of numerous comorbidities. It shows that there is a need for targeted strategies to improve patient care, mainly in ambulatory care, to reduce the rate of readmissions. Those components may have a significant impact on quality of life and costs of healthcare. It is also in-line with recommendations of investigators of the AMI-PL database, which suggest that cardiac rehabilitation and education in a field of self-management provided in patients after MI significantly reduced the number of readmissions [12].

Limitations of the study

The limitations of the study are a consequence of the analysed data. Registries have some drawbacks, such as their observational character and incompleteness of data. In the present study, data on hospitalisation at one year was missing for 133 out of the 649 patients, leaving 516 (80%) patients for the secondary endpoint analysis. However, there was no difference in the percentage of patients with missing data on hospitalisation between the analysed groups. Another limitation of the study is that a collection of information about previous coronary revascularisation in the registry was not the main objective of the study. This resulted in a lack of additional information about the severity of underlying CAD, the reason for not performing revascularisation in patients with known CAD, and the time from revascularisation to hospital admission. The type of revascularisation procedure (CABG or PCI) was also not analysed in this study. Our analysis aimed to characterise the whole population of HF patients who underwent previous coronary intervention (PCI or CABG) in comparison to those without previous revascularisation. The limited number of patients did not allow matching of both populations based on clinically relevant variables (i.e. ejection fraction, patients with already implanted ICD). Moreover, a longer duration of follow-up might be necessary to compare prognoses between study groups. Furthermore, it seems that performing a subanalysis of those patients' outcomes regarding ejection fraction might provide important findings.

CONCLUSIONS

In this analysis we characterised HF patients with prior PCI or CABG in comparison to the non-PCI/CABG group. The PCI/CABG patients were more likely to have numerous comorbidities, while the non-PCI/CABG patients more often had cardiogenic shock and died in hospital. Our results show that the HF patients who underwent revascularisation had a similar mortality and higher risk of death or hospitalisation at one year compared with the non-PCI/CABG patients. In the non-PCI/CABG patients an ischaemic aetiology of HF was observed less frequently, while the independent risk factors of the study endpoints were age, anaemia, and higher heart rate at discharge.

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