The journey of the heart failure patient, based on data from a single center

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Abstract

Background. Care for patients with heart failure (HF) in Poland requires improvement.

Objectives. The aim of this study was to define the journey of the HF patient, taking into account the specialization of the hospital ward and further, highly specialized outpatient care.

Material and methods. Using the medical system CliniNET[®], we analyzed 214 consecutive patients hospitalized due to HF (International Statistical Classification of Diseases and Health Related Problems – ICD-10: I50) in the period from September 1 to December 31, 2015, and also the data from post-discharge outpatient care in a 3-month period. To fairly compare the management of care and outcomes of patients hospitalized in the internal medicine (IM) ward and in the cardiac ward, propensity score matching was performed. The multivariate regression analysis was performed to determine the independent predictors of the hospital ward selection and the risk of rehospitalization due to HF and/or death.

Results. The majority of patients were hospitalized due to HF for the first time (72%) and in the cardiac ward (65%). For 55% of rehospitalized patients, the subsequent admission was within 3 months after initial discharge. The independent predictors of a higher risk of rehospitalization due to HF and/or death were ischemic heart disease, atrial fibrillation (AF), chronic kidney disease (CKD), mineralocorticoid antagonism (MRA) therapy, and hospitalization in the last year (for all, $p < 0.05$). Internal medicine ward patients differed from cardiac ward patients in: mode of admission (urgent 100% vs 83.5%; $p < 0.001$), length of hospitalization (median: 8 days vs 5 days; $p = 0.001$), death rate (24% vs 4.3%; $p < 0.001$), echocardiography (43% vs 98%; $p < 0.001$), and N-terminal prohormone B-type natriuretic peptide (NT-proBNP) measurements (43% vs 96%; $p < 0.001$). The burden of 5–9 accompanying diseases enhanced the choice of the cardiac ward ($p < 0.05$), while age and urgent mode of hospitalization decreased the chance of being referred to the cardiac ward ($p < 0.01$). Cardiac patients were more likely to receive β -blockers, diuretics, angiotensin receptor blockers (ARB), and MRA. Over 90% of cardiac ward patients were referred to cardiac ambulatory care after discharge from hospital, while among patients discharged from the IM ward, this rate was 60% ($p < 0.001$).

Conclusions. There were significant differences among the 2 wards in relation to the course of hospitalization and post-discharge outpatient care.

Key words: heart failure, hospitalization, cardiology, internal medicine

Introduction

Nowadays, heart failure (HF) is a major health issue, as it is associated with high prevalence, high death rates and large consumption of healthcare resources.^{1,2} Heart failure affects approx. 1–2% of adults in developed countries.³ Its prevalence rises significantly with age and, according to the latest data, the morbidity will further increase.⁴ Altogether, 1/5 of adult individuals will develop HF at some point.⁵

It is estimated that 30% of HF patients are readmitted to hospital within 60–90 days from initial hospitalization.^{6,7} In European studies, reported HF rehospitalization rates ranged from 24% at 12 weeks to 44% after 1 year post-discharge and had poor prognosis.^{8,9} In their study, Solomon et al. proved that the death rate in HF patients increased by 30% after the 2nd and 3rd readmission.¹⁰ Approximately 10% of HF patients die 60–90 days post-discharge.^{11,12} In Poland, 164 patients die every day due to HF, which amounts to over 60,000 deaths annually.¹³

According to the Organisation for Economic Co-operation and Development (OECD) 2015 report, Poland has the highest number of hospitalizations due to HF in the world.² The high numbers of hospitalizations for HF are a huge burden for healthcare systems. In 2012, the costs of HF patients' management reached 672 million PLN, of which 94% were hospitalization costs.¹³ Analyzing the economic and social costs in 2012, Gierczyński et al. documented that 75% of HF patients were hospitalized at internal medicine (IM) wards and 22% at cardiac wards.¹³ This fact became the basis of the hypothesis that there are differences related to the admission ward in terms of the characteristics of the hospitalized patient, diagnostic procedures, as well as in-hospital and post-discharge care.

The aim of this analysis was to assess the journey of the HF patient in Poland, based on the single-center experience, including the type of the admission ward and further cardiac outpatient care.

Material and methods

The study was designed as a questionnaire retrospective survey. It was conducted using questionnaire authoring, available in the electronic form. The standardized study questionnaires were designed to collect information on general characteristics of the patient group and to evaluate the HF patient management in the cardiac ward and the IM ward in the period from September 1 to December 31, 2015, in the Central Hospital of Medical University of Lodz, Poland, based on the available medical records. The survey was conducted using the medical system CliniNET®. The field studies dealt with the data on post-discharge outpatient care from the time of discharge to March 31, 2016. The questionnaire was constructed according to the applicable standards and rules concerning the collection of data through a survey. The questions concerned

the demographics, etiology and history of HF, the results of laboratory tests, applied treatment, death during or after hospitalization, and data on post-discharge outpatient care in a 3-month period. The data in the registry was verified and entered by specially trained physicians.

At baseline, the study included 214 consecutive patients. The inclusion criteria were as follows: hospitalization with I50 diagnostic code in the International Statistical Classification of Diseases and Health Related Problems (ICD-10) classification, hospitalization in the cardiac or IM ward in the Central Hospital of Medical University of Lodz, Poland, and hospitalization in the period from September 1 to December 31, 2015.

The study excluded patients hospitalized in the cardiac or IM ward with a diagnostic code other than I50 in the ICD-10 classification and patients hospitalized in other period. The structure of the study sample is presented in Table 1. The analyzed wards were researched regarding the medical

Table 1. Characteristics of the study population

Age [years], mean $\pm$ SD	72.2 $\pm$ 12.9
Males, n [%]	105 (49.1)
BMI [kg/m ²], median (IQR)	27.4 (24.28–31.2) ^a
SBP [mm Hg], median (IQR)	130 (115–140) ^a
DBP [mm Hg], median (IQR)	78 (70–85) ^a
Urgent mode of admission, n [%]	191 (89.2)
Arterial hypertension, n [%]	162 (75.7)
Coronary artery disease, n [%]	100 (46.7)
History of myocardial infarction, n [%]	54 (25.2)
CKD, n [%]	48 (22.4)
AF, n [%]	109 (50.9)
DM, n [%]	90 (42.1)
COPD, n [%]	30 (14.0)
Cancer, n [%]	15 (7.0)
ICD, n [%]	15 (7.0)
CRT, n [%]	7 (3.3)
LVEF [%], mean $\pm$ SD	42.2 $\pm$ 16.8
NT-proBNP on admission [pg/mL], median (IQR)	3,356 (2,204–10,341) ^a
Hb [g/dL], median (IQR)	12.9 (11–13.9) ^a
Sodium [mmol/L], median (IQR)	138.1 (133–143.2) ^a
Creatinine [μ mol/L], median (IQR)	98 (80.5–111.5) ^a
eGFR [mL/min/1.73 m ²], median (IQR)	61.4 (47.75–75.75) ^a
Fasting glucose [mmol/L], median (IQR)	6 (5.07–7.41) ^a
CRP [mg/L], median (IQR)	7.2 (2.9–21.8) ^a
Coronary angiography, n [%]	22 (10.3)

Data is presented as mean $\pm$ standard deviation (SD), median (interquartile range – IQR) or number (percentage). ^aVariables with non-parametric distribution. AF – atrial fibrillation; BMI – body mass index; CKD – chronic kidney disease; COPD – chronic obstructive pulmonary disease; CRP – C-reactive protein; CRT – cardiac resynchronization therapy; DBP – diastolic blood pressure; DM – diabetes mellitus; eGFR – estimated glomerular filtration rate; Hb – hemoglobin; ICD – implantable cardioverter defibrillator; LVEF – left ventricle ejection fraction; NT-proBNP – N-terminal prohormone B-type natriuretic peptide; SBP – systolic blood pressure.

records of the hospitalized patients with the final HF diagnosis.

The patients' medical history was taken, a physical examination was performed and basic laboratory results were assessed in all study patients on admission. The clinical symptoms of HF were classified according to the New York Heart Association (NYHA).¹⁴

Echocardiographic measurements were performed according to the guidelines of the American Society of Echocardiography (ASE) and European Association of Echocardiography (EAE).¹⁵ A coronary arteriography was performed as needed according to the ASE/EAE and European Society of Cardiology (ESC) recommendations.¹⁶ Heart failure with reduced ejection fraction (HFrEF) was diagnosed when the left ventricle ejection fraction (LVEF) measurement was less than 40%.¹⁷ Heart failure with preserved ejection fraction (HFpEF) was diagnosed when the LVEF measurement remained greater than 50%.¹⁷

The following parameters were analyzed in this study:

- age, gender, body mass index (BMI), arterial blood pressure, coincidence of arterial hypertension, diabetes mellitus (DM), myocardial infarction, coronary artery disease, atrial fibrillation (AF), renal failure, chronic obstructive pulmonary diseases (COPD), cancer, coronary artery bypass graft (CABG), and electrotherapy history: cardiac resynchronization therapy (CRT)/implantable cardioverter defibrillator (ICD);
- HF etiology (ischemic vs non-ischemic: hypertension, valvular disease, congestive cardiomyopathy, myocarditis, toxic cardiomyopathy, tachyarrhythmic cardiomyopathy) and past history of HF;
- mode (urgent vs planned) and length of current hospitalization;
- selected laboratory results: hemoglobin (Hb), sodium, potassium, creatinine, estimated glomerular filtration rate (eGFR), C-reactive protein (CRP), fasting glucose, and N-terminal prohormone B-type natriuretic peptide (NT-proBNP);
- electrocardiography (ECG) variables: heart rhythm, heart rate (HR), left bundle branch block (LBBB);
- selected echocardiographic results, including LVEF;
- coronary arteriography results;
- drugs and doses of standard HF therapy prescribed at discharge: angiotensin-converting-enzyme inhibitors (ACEI), angiotensin receptor blockers (ARB), β -blockers, mineralocorticoid antagonist (MRA), ivabradine, and diuretics;
- death during or after hospitalization;
- post-discharge outpatient care.

The collected data was subjected to hospital ward- and endpoint-related statistical analysis. The endpoints were as follows: HF rehospitalization and/or death.

Statistical analysis was conducted using the statistical package STATISTICA PL v. 10.0 (StatSoft Polska Sp. z o.o., Kraków, Poland). Continuous variables were first evaluated for normal distribution using the Shapiro-Wilk test. We also checked data distribution. The Mann-Whitney test

was used to compare continuous variables. All continuous variables were expressed as mean, median, interquartile range (IQR, Q25–Q75), and standard deviation (SD); categorical variables were expressed as the number of observations (n) and the corresponding percentage (%). The χ^2 test was used to compare the qualitative data between the groups. Fisher's exact test for independence (in lower numbers) was used. The odds ratio (OR) and a 95% confidence interval (95% CI) were assigned. All statistical tests were two-sided. All variables significantly associated ($p < 0.05$) with the selection of a hospital ward and a higher risk of rehospitalization and/or death in the univariate model were included in the multivariate regression analysis to determine the independent predictors of the hospital ward selection and the risk of rehospitalization and/or death. Results were considered statistically significant at $p < 0.05$. All tables present only the variables which differ or have been selected in the context of the article.

The study design was approved by the Bioethics Committee of Medical University of Lodz, Poland (No. RNN/38/16/KE).

Data was collected and processed maintaining confidentiality of the patients and physicians participating in the study.

To adequately compare the management of care and outcomes of the patients hospitalized in the 2 wards, we had to create identical groups of patients in terms of the epidemiological data, frequency of comorbidities, etiology of HF, and clinical status on admission to hospital, by means of propensity score matching.

Results

The final study sample included 214 patients. Detailed characteristics of the study population are presented in Table 1. The studied cohort suffered the most common comorbidities including: arterial hypertension, AF, coronary artery disease, DM, and chronic kidney disease (CKD).

The majority of the studied patients were admitted in an urgent mode ($n = 191$; 89%) and hospitalized in the cardiac ward ($n = 139$; 65%). Comparing to cardiac ward patients, IM ward patients were older, more likely to have accompanying infection, as well as higher systolic blood pressure (SBP) and HR at discharge (Table 2). Internal medicine ward patients had less devices – ICD (1.3% vs 10%; $p = 0.035$) or CRT (0 vs 5%; $p = 0.099$) and history of myocardial infarction (10.7% vs 33%; $p = 0.001$).

According to the results of the univariate analysis, the significant variables for choosing the cardiac ward on admission were as follows: sex, age, mode of hospitalization (urgent vs planned), number of comorbidities, AF, and LVEF ($>40\%$ vs $\leq 40\%$). The multivariate regression analysis revealed the independent predictors of choosing the cardiac ward (Table 3). The burden of 5–9 accompanying diseases enhanced the choice of the cardiac ward more than 5-fold (Table 3), while age and urgent mode

Table 2. Comparison between hospitalizations in cardiac and internal medicine (IM) wards

Variables	Cardiac ward	IM ward	p-value
All patients, n [%]	139 (65.8)	75 (35.0)	–
Males, n [%]	76 (54.7)	29 (38.7)	0.591
Age [years], median (IQR)	72.0 (62.0–80.0) ^a	81.0 (72.0–86.0) ^a	<0.001
BMI [kg/m ²], mean ±SD	28.75 ±6.1	27.99 ±5.8	0.611
SBP [mm Hg], median (IQR)	126 (110–140) ^a	135 (120–140) ^a	0.007
DBP [mm Hg], median (IQR)	75 (66–80) ^a	80 (70–85) ^a	0.092
HR on admission [bpm], median (IQR)	76 (70–90) ^a	880 (70–100) ^a	0.168
HR at discharge [bpm], median (IQR)	70 (64–75) ^a	76 (70–80) ^a	<0.001
Comorbidities			
Underweight, n [%]	0	2 (4.4)	0.142
Overweight, n [%]	52 (38.8)	14 (31.1)	0.142
Obesity, n [%]	42 (31.3)	15 (33.3)	0.142
Coronary artery disease, n [%]	71 (51.1)	29 (38.7)	0.111
AF, n [%]	73 (52.5)	36 (48.0)	0.626
DM, n [%]	57 (41.0)	33 (44.0)	0.781
Arterial hypertension, n [%]	108 (77.7)	54 (72.0)	0.447
CKD, n [%]	27 (19.4)	21 (28.0)	0.207
COPD, n [%]	18 (12.9)	12 (16.0)	0.684
Cancer, n [%]	8 (5.8)	7 (9.3)	0.485
Infection, n [%]	20 (14.4)	33 (44.0)	<0.001
Current hospitalization			
Urgent hospitalization, n [%]	116 (83.5)	75 (100)	<0.001
Length of hospitalization [days], median (IQR)	5 (3–8) ^a	8 (5–10) ^a	0.001
Death in-hospital, n [%]	4 (2.9)	15 (20.0)	<0.001
Death post-discharge, n [%]	2 (1.4)	3 (4.0)	<0.001
Access to ambulatory care			
Referral to a cardiology outpatient clinic, n [%]	127 (91.9)	45 (60.0)	<0.001
Control visit in a cardiology clinic, n [%]	44 (35.5)	7 (18.9)	0.089
<1 month, n [%]	16 (36.4)	1 (14.3)	0.007
1–3 months, n [%]	9 (20.5)	0	0.007
unknown, n [%]	4 (9.1)	5 (71.4)	0.007
Pharmacotherapy			
ACEI, n [%]	87 (62.6)	42 (56.0)	0.427
ARB, n [%]	27 (19.4)	5 (6.7)	0.022
β-blockers, n [%]	124 (89.2)	55 (73.3)	0.005
MRA, n [%]	47 (85.5)	5 (50.0)	0.022
Ivabradine, n [%]	4 (26.7)	0	1.000
Diuretics, n [%]	120 (86.3)	52 (69.3)	0.005

Data is presented as mean ± standard deviation (SD), median (interquartile range – IQR) or number (percentage). A p-value <0.05 is considered statistically significant. ^a Variables with nonparametric distribution. A p-value <0.05 is considered statistically significant. ACEI – angiotensin-converting-enzyme inhibitors; AF – atrial fibrillation; ARB – angiotensin receptor blockers; BMI – body mass index; CKD – chronic kidney disease; COPD – chronic obstructive pulmonary disease; DBP – diastolic blood pressure; DM – diabetes mellitus; HR – heart rate; IM – internal medicine; MRA – mineralocorticoid antagonism; SBP – systolic blood pressure.

of hospitalization decreased the chance of choosing the cardiac ward (Table 3).

As compared to IM ward patients, cardiac ward patients were more likely to undergo echocardiography (98% vs 43%; $p < 0.001$) and the measurements of NT-proBNP concentration (96% vs 43%; $p < 0.001$). For the whole

population, the median NT-proBNP concentration was high, with a median of 3356 pg/mL (IQR = 2,204–10,341). Based on the available echocardiography results ($n = 168$), the mean LVEF was $42.2 \pm 16.8\%$. Among patients with ejection fraction (EF) data, 44.04% had HFpEF and 55.96% had HFrEF. Based on the available ECG results ($n = 212$),

Table 3. Results of the multivariate regression models

Variables	Exp (B) – OR	95% CI for OR		p-value
Choice of the cardiac ward				
Sex: women vs men	0.83	0.33	2.09	0.689
Age [years]	0.93	0.91	0.96	<0.001
Number of comorbidities:				
1–3	1.52	0.53	4.31	0.436
3–5	2.15	0.71	6.45	0.174
5–9	5.46	1.20	24.85	0.028
Mode of hospitalization: urgent vs planned	0.31	0.14	0.67	0.003
AF	1.25	0.51	3.06	0.631
LVEF: >40% vs ≤40%	0.90	0.35	2.34	0.832
Rehospitalization and/or mortality				
Ischemic heart disease	4.65	1.32	16.34	0.017
AF	5.24	1.81	15.13	0.004
Arterial hypertension	0.13	0.05	0.36	<0.001
Valvular disease	0.47	0.19	1.16	0.102
CKD	3.62	1.06	12.30	0.04
The number of comorbidities: 0–3 vs 3–8	0.37	0.11	1.27	0.115
MRA therapy	2.57	1.05	6.26	0.038
Mode of hospitalization: planned vs urgent	0.19	0.05	0.77	0.02
Hospitalization in the last year	64.17	7.29	564.75	<0.001
Hospital ward: cardiac vs IM	0.2	0.08	0.52	<0.001

A p-value <0.05 is considered statistically significant. AF – atrial fibrillation; CKD – chronic kidney disease; CI – confidence interval; IM – internal medicine; LVEF – left ventricle ejection fraction; MRA – mineralocorticoid antagonism; OR – odds ratio.

in 17.9% of the hospitalized HF patients ($n = 38$), LBBB with QRS duration >120 ms was registered in 12-lead ECG. Most of them were hospitalized in the cardiac ward ($n = 31$; 81.6%). About half of patients with LBBB ($n = 20$; 52.6%) had reduced EF (LVEF ≤ 35%).

Atrial fibrillation was observed in 50.9% of the hospitalized patients ($n = 109$) and more often in cardiac ward patients (52.5% vs 48%), although not statistically significantly. In AF patients, the median baseline HR on admission was 80 bpm (IQR: 60–106; HR_{max} – 160 bpm) and at discharge 70 bpm (IQR: 60–80; HR_{max} – 120 bpm).

Ischemic etiology of HF was present in 31.3% of patients ($n = 67$). Regarding non-ischemic etiology, arterial hypertension was present in 49% of patients ($n = 105$), 38.8% had valvular disease ($n = 83$), 7.5% had congestive cardiomyopathy ($n = 16$), and 8.4% had other etiology, namely, toxic cardiomyopathy or tachyarrhythmic cardiomyopathy.

Coronary angiography was performed in 10% of the cardiac patients ($n = 22$) and slightly more than a half of them ($n = 13$; 59%) showed no significant atherosclerosis in the coronary arteries; in 1 case, the myocardial bridge was observed, and in the other one, percutaneous coronary intervention and CABG surgery were performed. Some of the cardiac ward patients also underwent dobutamine

stress echocardiography (DSE). Patients from the study group were also qualified for coronary computed tomography angiography ($n = 6$) and cardiac magnetic resonance imaging.

Most of the patients ($n = 145$; 67.8%) were hospitalized for 3–8 days, but significantly shorter in the cardiac ward than in the IM ward (Table 2). As opposed to cardiac ward patients, all IM ward patients were hospitalized immediately (Table 2). Most of the studied patients ($n = 154$; 72%) were hospitalized due to HF for the first time. For most of them ($n = 93$; 60.4%), it was hospitalization due to HF exacerbation, but for 61 patients (39.6%), it was hospitalization due to acute HF de novo. Additionally, 8 patients (5.2%) with acute HF de novo also had LVEF ≤ 35% during current hospitalization. Sixty patients were rehospitalized; for 18 of them (30%), the rehospitalization took place within 1 month after initial discharge and for 33 of them (55%) within 3 months after initial discharge. Twelve patients (20%) were readmitted to hospital after 6 months. For the majority of the rehospitalized patients ($n = 50$; 83%), current hospitalization was the 2nd or 3rd HF hospitalization.

Compared to the patients hospitalized for the first time, the rehospitalized patients were more likely to have AF,

LVEF $\leq$ 40%, ischemic etiology of HF, history of myocardial infarction, CKD, and 3–8 accompanying diseases (for all, $p < 0.05$). These patients had lower SBP (mean: 133.42 vs 126.24 mm Hg; $p = 0.032$) and diastolic blood pressure (DBP) (mean: 78.82 vs 75.00 mm Hg; $p = 0.04$) on admission, had more frequently at least 1 HF hospitalization in the past year (1.5% vs 40.1%; $p < 0.001$), their hospitalizations were longer (mean: 5.30 vs 7.56 days; $p < 0.001$), they were more frequently hospitalized urgently (77.6% vs 94.6%; $p = 0.001$) and admitted to IM ward (20.9% vs 41.5%; $p = 0.006$).

The characteristics of the studied patients related to re-hospitalization and/or death are presented in Table 4. The mortality rate was higher for IM ward patients ($p < 0.001$), both during and after hospitalization (Table 2).

The univariate analysis presents the following significant variables for a higher risk of rehospitalization and/or death: ischemic heart disease, LVEF $\leq$ 40%, AF, arterial hypertension, valvular disease, CKD, number of comorbidities, MRA therapy, mode of hospitalization, hospitalization in the last year, and hospitalization in the IM ward. The independent predictors of a higher risk of rehospitalization

Table 4. Characteristics of the study population related to rehospitalization and/or death

Variables	No rehospitalization and/or death	Rehospitalization and/or death	p-value
All patients, n [%]	67 (31.3)	147 (68.7)	–
Age [years], mean $\pm$ SD	71.6 $\pm$ 11.81	73.96 $\pm$ 13.36	0.216
LVEF $\leq$ 40%, n [%]	17 (28.8)	62 (56.9)	0.001
HR on admission [bpm], mean $\pm$ SD	79.3 $\pm$ 17.68	84.29 $\pm$ 20.42	0.086
HR at discharge [bpm], mean $\pm$ SD	70.27 $\pm$ 9.61	72.64 $\pm$ 10.64	0.121
Comorbidities			
Number of comorbidities: 0–3, n [%]	54 (80.6)	81 (55.1)	0.001
Number of comorbidities: 3–8, n [%]	13 (19.4)	66 (44.9)	0.001
Coronary artery disease, n [%]	21 (31.3)	79 (53.7)	0.004
History of myocardial infarction, n [%]	8 (11.9)	46 (31.3)	0.004
AF, n [%]	25 (37.3)	84 (57.1)	0.011
DM, n [%]	24 (35.8)	66 (44.9)	0.272
Arterial hypertension, n [%]	57 (85.1)	105 (71.4)	0.047
CKD, n [%]	6 (9.0)	42 (28.6)	0.003
COPD, n [%]	5 (7.5)	25 (17.0)	0.098
Cancer, n [%]	5 (7.5)	10 (6.8)	1.00
Etiology of HF			
Ischemic heart disease, n [%]	8 (11.9)	59 (40.1)	<0.001
Hypertension, n [%]	46 (68.7)	59 (40.1)	<0.001
Valvular disease, n [%]	25 (37.3)	58 (39.5)	0.883
Congestive cardiomyopathy, n [%]	2 (3.0)	14 (9.5)	0.160
Other ^a , n [%]	8 (11.9)	10 (6.8)	0.322
Current hospitalization			
Urgent hospitalization, n [%]	52 (77.6)	139 (94.6)	0.001
Length of hospitalization [days], mean $\pm$ SD	5.3 $\pm$ 2.81	7.56 $\pm$ 4.17	0.001
Hospitalization in the last year, n [%]	1 (1.5)	59 (40.1)	<0.001
Pharmacotherapy			
ACEI, n [%]	42 (62.7)	87 (59.2)	0.738
ARB, n [%]	15 (22.4)	17 (11.6)	0.064
β -blockers, n [%]	61 (91.0)	118 (80.3)	0.076
MRA, n [%]	36 (53.7)	99 (67.3)	0.078
Ivabradine, n [%]	2 (3.0)	7 (4.8)	0.815
Diuretics, n [%]	53 (79.1)	119 (81.0)	0.886

Data is presented as mean $\pm$ standard deviation (SD) or number (percentage). A p-value < 0.05 is considered statistically significant. ^a toxic cardiomyopathy, tachyarrhythmic cardiomyopathy; ACEI – angiotensin-converting-enzyme inhibitors; AF – atrial fibrillation; ARB – angiotensin receptor blockers; CKD – chronic kidney disease; COPD – chronic obstructive pulmonary disease; DM – diabetes mellitus; HF – heart failure; HR – heart rate; LVEF – left ventricle ejection fraction; MRA – mineralocorticoid antagonism.

Table 5. Analysis of standard heart failure (HF) pharmacotherapy

Variables	Yes	<50% of target dose	≥50% of target dose	Target dose
ACEI, n [%]	129 (60.3)	67 (51.9)	37 (28.7)	25 (19.4)
ARB, n [%]	32 (15.1)	12 (37.5)	19 (59.4)	1 (3.1)
β-blockers, n [%]	179 (83.6)	87 (48.6)	74 (41.3)	18 (10.1)
MRA, n [%]	135 (63.1)	4 (3.0)	32 (23.7)	99 (73.3)

A p-value <0.05 is considered statistically significant. ACEI – angiotensin-converting-enzyme inhibitors; ARB – angiotensin receptor blockers; MRA – mineralocorticoid antagonism.

and/or death in the multivariate regression model are presented in Table 3.

At discharge, over 90% of cardiac ward patients and only 60% of IM ward patients were referred to outpatient cardiac clinics ($p < 0.001$). All LBBB patients had a cardiologist's consultation during the 3-month follow-up after the HF hospitalization, regardless of the hospital department (IM vs cardiac). Slightly over a half of cardiac ward patients (56.9%) and none of IM ward patients had their 1st ambulatory appointment in a period shorter than 3 months post-discharge (Table 2).

The majority of the hospitalized patients were under the optimal medical treatment of HF (ACEI/ARB, β-blockers, MRA). More than 80% of all hospitalized patients and more than 90% ($n = 101$) of AF patients were taking β-blockers. The percentage of patients receiving ACEI or ARB reached more than 75% (Table 5). However, cardiac ward patients more frequently than IM ward patients received β-blockers, diuretics, ARB, and MRA (Table 2). None of IM ward patients, and only 4 patients in the cardiac ward, received ivabradine (Table 2).

Despite the fact that β-blockers were prescribed most often, in the majority of cases, they were prescribed in <50% of the target dose. Only 10% of all studied patients received the target dose of β-blockers for HF. The population of AF patients, in the majority of cases (53.5%; $n = 54$), also received β-blockers in 50% or <50% of the target dose. The others (33.6%; $n = 34$) received β-blockers in >50% of the target dose and only 12.87% ($n = 13$) of AF patients were under the target dose of β-blockers. Otherwise, about half of AF patients (51.4%; $n = 56$) had therapy with digoxin as concomitant therapy.

Similarly, only 20% of patients received the ACEI target dose and less than 5% received the ARB target dose. In the studied population, only in MRA treatment, over 70% of patients reached the recommended target dose (Table 5). However, cardiac ward patients more frequently than IM ward patients received diuretics in the target dose (30% vs 7%; $p < 0.001$).

Discussion

The presented analysis is to our best knowledge the first analysis of Polish HF patients distinguishing between admission wards. No other project in Poland compared the

in-hospital and post-discharge management of HF patients in relation to hospital admission wards – cardiac vs IM. This analysis showed differences in guideline implementation between the 2 studied hospital wards.

The HF population from our study is similar to the general Polish HF population analyzed in 2012, in terms of the mode of admission and median length of hospitalization.¹³ However, in the 2012 report, 75% of HF patients were hospitalized in IM wards and 22% in cardiac wards.¹³ In our study, these proportions are different, which is related to the high specialization of the cardiac department in HF. Similarly to the 2012 HF analysis, we found longer hospitalization in the IM ward than in the cardiac ward (median of 7 and 6 days in the 2012 report vs 7.56 and 5.30 days in our study, respectively). Also, similarly to the 2012 analysis, the majority of HF patients were admitted due to acute decompensation of HF (83% of all HF hospitalizations in 2012 vs 89% in the studied population).¹³ Most of the studied patients ($n = 154$; 72%) were hospitalized due to HF for the first time. For 61 patients (39.6%), it was hospitalization due to acute HF de novo. Additionally, 8 patients (5.2%) with acute HF de novo had also LVEF ≤35% during current hospitalization. These patients, after 3 months of optimal medical treatment, should be reevaluated by a cardiologist, taking into account the ECG analysis and echocardiography measurement of LVEF, before the final decision on electrotherapy.

From the HF exacerbation subgroup, 54 patients also had LVEF ≤35% during current hospitalization. Taking into account 3 months of optimal pharmacological therapy for HF, the ECG analysis and ongoing clinical indications, the patients should be potentially qualified for electrotherapy. Additionally, in 17.9% of the hospitalized HF patients ($n = 38$), LBBB with QRS duration >120 ms was registered in 12-lead ECG. About half of patients with LBBB ($n = 20$; 52.6%) had reduced EF (LVEF ≤35%). This is an important group of HF patients in terms of qualifying for electrotherapy. According to the valid guidelines in the period of our study (the 2013 ESC guidelines on cardiac pacing and cardiac resynchronization therapy), a cardiac resynchronization therapy and defibrillator (CRT-D) should be considered in patients with LBBB with QRS duration of 120–150 ms (class of recommendation 1, level of evidence B), or >150 ms (class of recommendation 1, level of evidence A), with chronic HF and LVEF ≤35%, who

remain in NYHA functional class II, III and ambulatory IV despite 3 months of optimal medical treatment.^{1,18}

In 2012, the overall death rate for HF patients in Poland was 11%.¹³ In our short-term analysis of hospitalization and the 3-month period after discharge, the overall death rate was 11.2%. The mortality rate was higher for IM ward patients ($p < 0.001$), both during and after hospitalization (Table 2).

So far, European and Canadian studies have shown specialty-related differences in the management and prognosis of HF patients.^{19–22} In countries such as Italy, Spain and Canada, the admission ward was related to a clear dissimilarity in the process of diagnosis and treatment.^{19–22} In these studies, as well as in our analysis, IM ward patients were older, had more co-morbidities and their hospitalizations were longer.

According to the results of our analysis, HF management in Poland, compared to other European countries and Canada, seems to be similar in terms of differences between IM and cardiac departments. In a study from Italy, similar to our population, patients treated by cardiologists were more likely to be prescribed ACEI and β -blockers at discharge than IM ward patients (100% vs 74% and 41% vs 4%, respectively).²⁰ Patients receiving a follow-up by cardiologists were younger than IM ward patients (median: Canada – 71.7 vs 75.8 years; Italy – 70 vs 79 years, Spain – 72.5 vs 77.4 years, respectively).

Unlike in Poland, in other analyzed countries, there was no statistical significance in terms of in-hospital and post-discharge mortality in relation to the type of admission ward.

Post-discharge care in HF patients with regular ambulatory visits is strongly indicated.¹ Based on the new ESC guidelines, the HF patient should be examined by a general practitioner (GP) within 1 week of discharge and by the hospital cardiology team within 2 weeks of discharge.¹ However, none of the abovementioned European and Canadian studies focused on post-discharge care.^{18–21} Another important observation from our study is that cardiac ambulatory care was more often recommended in the case of patients hospitalized in cardiac wards as compared to IM wards (90% vs 60%). In our study, the number of referrals of the cardiac patients to outpatient cardiac care did not differ significantly from the general HF population results in 2012, in contrast to IM patients. Compared to the 2012 analysis, in our study, more of all hospitalized patients were referred to ambulatory cardiac care after discharge (80% in our study vs 70% in the 2012 report).¹³ In our study, all LBBB patients had a consultation with a cardiologist during the 3-month follow-up after HF hospitalization, regardless of the hospital department (IM vs cardiac). Compared to the general hospitalized HF population in this study, this was a very good result, because at discharge over 90% of cardiac ward patients and only 60% of IM ward patients were referred to an outpatient cardiac clinic ($p < 0.001$).

Another important issue is that patients hospitalized in the IM ward were more likely to have a worse baseline general condition, e.g., they more often had CKD (although not statistically significantly), had a significantly higher mean age (by almost 10 years) and were more often admitted urgently, e.g., due to infection.

Many variables of significance for cardiac events in HF are described in the literature. One of the most important is older age. In the elderly, the most common cause of hospitalization is HF. In people over 70 years of age, HF affects 1/10 of seniors and is the leading cause of death in this age group.^{1,23–25} In seniors over 80 years of age, comorbidities also have an important prognostic value for annual prognosis in chronic HF.²⁵ In our study, a worse baseline general condition with comorbidities, such as ischemic heart disease, AF and CKD, are independent variables for longer hospitalization and/or mortality.

It should also be emphasized that there are differences in characteristics and diagnostic procedures performed in cardiac and IM wards. In IM departments, only 43% of patients underwent, at the same time, echocardiography with the measurement of LVEF and natriuretic peptides. In our study, in the majority of cardiac ward patients, opposite to IM ward patients, the echocardiography and NT-proBNP measurement were performed. It is worth noticing that biomarkers are crucial for the diagnosis and professional management of HF.²⁶ In other European studies, patients managed by cardiologists were also more likely than IM wards patients to undergo echocardiography (Italy: 89–92% vs 37–54.8%).^{20,21}

Compared to our findings, in EURObservational Research Programme The Heart Failure Pilot Survey (ESC HF-Pilot), BNP/NT-proBNP measurements as well as echocardiography were performed much more frequently in patients hospitalized in our cardiac ward (96% vs 36.6% and 98% vs 75%, respectively). The results were different in the IM ward (43% vs 36.6%, and 43% vs 75%, respectively).⁹ The studied HF population was burdened with comorbidities similar to those of the individuals from ESC-HF Pilot, most frequently coronary artery disease, hypertension, CKD, and DM.^{27,28}

Although the ESC-HF Pilot population ($n = 5118$) differed significantly from our HF population in terms of the admission mode to a cardiac ward (for acute HF – 37% vs 83.5% and for chronic HF – 63% vs 16.5%, respectively), the median length of stay in a cardiac ward in ESC-HF Pilot was higher than in our study (8 vs 5 days, respectively).²⁷ It should be highlighted that ESC-HF Pilot included only patients hospitalized in cardiac departments. ESC-HF Pilot population was treated mainly with ACEI and β -blockers (80%). However, target doses were reached in 1/3–1/4 of the ESC-HF Pilot patients only. Even lower results of the target dose achievement were observed in our study (19.4% for ACEI and 10% for β -blockers).

The Polish population from ESC-HF Pilot was younger compared to our study (66 ± 13.7 vs 72.2 ± 12.9 years,

respectively).²⁹ Angiography confirmed that coronary artery disease was the main etiology of HF in Polish patients from the registry (39%). The analysis of data from our study showed that, as proven in the ESC-HF Pilot study, ischemic etiology of HF was very common among cardiac ward patients (51%).

The 3-month death rate for ESC-HF Pilot Polish patients was estimated at about 2.5%, while it was 3% in other European countries. Meanwhile, it is noteworthy that, in our study, the death rate was at a lower level than in the ESC-HF Pilot study – 2.9% in-hospital and 1.4% post-discharge.

A recently published global survey shows the implementation of guideline-recommended HF treatment.³⁰ In the QUALIFY survey, as well as in the cardiac HF population from our study, the majority of patients were treated with ACEI (65.7% vs 62.6%), β -blockers (86.7% vs 89.2%) and diuretics (83% vs 86.3%). Ivabradine has proven its efficacy in reducing hospitalizations for 26% in the SHIFT study.³¹ In our analysis, it was observed that cardiologists prescribed this drug at discharge to a greater extent than internists, but still with a very low frequency (26.7% vs 0, respectively). In the QUALIFY survey, the number of patients treated with ivabradine was above 33.4%.³⁰

The optimal HF therapy at discharge in our study and in the QUALIFY survey was poor. However, target doses were at a better rate in the QUALIFY survey than in the studied population – 27.9% vs 19.4% for ACEI and 14.8% vs 10.1% for β -blockers.³⁰

Compared to the QUALIFY registry, the frequency of use of implantable devices, such as ICD or CRT, was also poor in both studies, but at a better rate in QUALIFY survey than in our study – 9.7%.³⁰

A crucial observation from our study is that HF hospitalization in the previous 12 months was the most important risk factor for subsequent hospitalizations. The results of the QUALIFY survey showed that 30.4% of patients had a history of 2 or more HF hospitalizations.³⁰ In the ESC-HF Pilot study, 57% of HF population had a history of previous hospitalizations and, additionally, 24.75% of patients were rehospitalized in a 1-year follow-up.^{27,29}

This study has some limitations that have to be acknowledged. Firstly, it should be noted that it was a retrospective analysis. Inclusion criteria were based only on diagnostic code I50 in the ICD-10 classification and on the data available in the medical system CliniNET®, not on medical assessment.

Other limitations are that the study included only a 3-month period of follow-up and analyzed the adherence score to guideline recommendations for only standard HF treatment according to the ESC recommendations (3 groups of drugs: ACE/ARB, β -blockers and MRA), and additional ivabradine and diuretics without digoxin or nitrates.

Moreover, we made a hospital ward- and endpoint-related statistical analysis, but it was carried out with the EF value (HFrEF vs HFpEF).

Despite the advances in clinical practice, as documented in our analysis and previous publications, there is still a place for improvement in terms of the diagnosis of HF, determination of prognosis and treatment selection.

In conclusion, the single-center study has shown that the management of HF patients differs significantly depending on the admission ward. The differences include diagnostic procedures, hospitalization, treatment, ambulatory care, and prognosis, showing the advantages of cardiac wards. The presented results of the journey of HF patients indicate the need for improvement in the field of HF care.

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