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Original scientific paper

Prognostic Indicators for First and Repeated Hospitalizations in Heart Failure Patients with Reduced Left Ventricular Ejection Fraction

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ABSTRACT

Heart failure with reduced ejection fraction (HFrEF) is a progressive clinical syndrome defined by changes in the myocardial structure, which lead to predominant systolic myocardial function impairment, with a left ventricle ejection of fraction ≤40%. The rehospitalization burden in HFrEF patients (pts) remains very high, with poor quality of life, increased mortality and large healthcare expenditures. In this research project, we investigated the risk factors for first and repeated hospitalization in pts with HFrEF. This retrospective study included 50 adult pts with a diagnosis of HFrEF and who were within the age range of 55 to 89 years old and of both sexes. Demographic and clinical data (HFrEF etiology, renal function parameters, complete blood count, markers of inflammation, electrocardiogram, troponin I, NTproBNP, echocardiographic parameters and comorbidities data) were collected from the pts' medical histories. Statistical analysis was performed via Fischer's exact test, the Shapiro-Wilk test and the Spearman correlation coefficient. This study included 70% male and 30% female HFrEF pts. Males were younger in both group of pts and had a higher incidence of rehospitalization. The most important HFrEF etiologic risk factors are arterial hypertension (82%), coronary heart disease (54%), atrial fibrillation (52%) and diabetes mellitus (40%). The most important noncardiac comorbidity related with the first HFrEF hospitalization is pneumonia (P=0.03), while progression of left ventricle systolic and diastolic dysfunction is related to rehospitalization risk (left ventricle end systolic diameter, P=0.003; diastolic dysfunction degree, P=0.04). The troponin level was associated with an increased risk of rehospitalization, but this was not statistically significant at this sample size (troponin I, p=0.10). Following the first and repeated hospitalizations of HFrEF pts, comorbidities, ageing and gender difference are crucial to HFrEF development, while echocardiographic parameters and biomarkers critically affect HFrEF rehospitalization risk.

Key words: *atrial fibrillation, arterial hypertension, coronary heart disease, echocardiography, diabetes mellitus, heart failure, patient readmission*

Introduction

Heart failure (HF) is a clinical syndrome with a progressive course that is caused by changes in the structure or function of the myocardium, leading to the impairment of systolic and/or diastolic myocardial function[1,2]. These changes reduce the heart's ability to pump blood, resulting in a lack of adequate blood supply to the body. It is most commonly caused by diseases that affect the myocardium, but disorders that affect other parts of the cardiac system, including the pericardium, endocardium, heart valves and blood vessels can also lead to heart failure syndrome[1]. Most commonly, it is caused by coronary heart disease (CHD), arterial hypertension (HTA), diabetes mellitus (DM) and atrial fibrillation (AF)[2,3]. Based on left ventricular ejection fraction (LVEF), HF can be divided into heart failure with reduced ejection fraction (HFrEF < 40 %), mid-range EF (mrEF 40 – 49 %) and preserved EF (HFpEF ≥ 50 %)[1].

The epidemiology of HF is on the rise, and HF is now one of the most common causes of hospitalizations in developed western countries, at nearly one million hospitalizations per year[4]. The overall prevalence is 1–2 % and increases in proportion with the patient's age. Among those younger than 50 years old, it occurs in less than 1% of all cases, while it occurs in more than 10% of cases in

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people more than 70 years old[5]. Heart failure can present as acute or chronic and can affect the left, right or both sides of the heart. Acute HF presents suddenly and is most commonly caused by massive myocardial infarction or papillary muscle rupture. On the other hand, chronic HF is longer in duration and usually caused by CHD, HA, cardiomyopathies and heart valve diseases[6]. HF is characterized by classic symptoms that are most often accompanied by signs. Symptoms include dyspnea, orthopnea, paroxysmal nocturnal dyspnea, nocturia, fatigue and weakness. Some of the most common signs that accompany these symptoms include distended jugular veins of the neck, auscultatory third heart tone (gallop rhythm), bilateral auscultatory wheezing, hepatomegaly and peripheral edema of the legs[7]. However, the symptoms are nonspecific and difficult to distinguish from those of other diseases, especially in the elderly, obese, and pts with chronic lung disease[8]. Heart failure can be functionally classified using the NYHA classification system, based on whether symptoms occur during exertion or even while at rest[9]. Heart failure should already be suspected based on the clinical presentation and confirmed with the HF biomarker N-terminal pro b-type natriuretic peptide (NTproBNP). In addition to making a diagnosis, NTproBNP is used in the gradation of the disease and as a response to therapy. Due to the volume and pressure load that occurs in pts with HF, NTproBNP is released into the bloodstream[1]. Patients whose plasma values are within the reference values usually do not have HF, while in pts with elevated values, further diagnostic processing is required[1]. Echocardiography is used as the gold standard in diagnosis because it provides information on the structure and function of the myocardium, valvular diseases, heart chamber volumes and hemodynamics[10].

HF is most commonly associated with a number of other serious diseases that affect the stability of the disease itself, increase the need for rehospitalization, worsen clinical status, and lower the outcome of the predictors. The presence of comorbidities can affect the choice of medications, while comorbidity medications can result in a significant worsening of HF[11]. Age, sex, etiology, LVEF, NYHA classification, NTproBNP, and the presence of numerous comorbidities negatively affect disease prognosis and increase the risk of rehospitalization, especially within the first month[1]. The most common cardiac and noncardiac comorbidities include AF, HA, CHD, DM, asthma, chronic obstructive pulmonary disease (COPD), peripheral arterial disease, valvular defects, anemia, hyperlipidemia and malignancies[12]. The need for rehospitalization is a negative prognostic factor, and it affects the further deterioration of LVEF and increases the risk of morbidity and mortality. Over the past thirty years, advances in treatment have reduced the need for hospitalization, although the outcomes often remain unsatisfactory[1].

The main purpose of this study is to obtain data about HFrEF pts, their comorbidities and other medical parameters which could cause HF worsening and the need for first and repeated hospitalization.

Materials and Methods

This research presents a cross-sectional retrospective study. The study included 50 adult patients (pts) of both sexes, with age ranging from 55 to 89 years and with a diagnosis of heart failure with reduced ejection fraction (HFrEF), treated during 2019 (from January to June), at the Department for Heart and Vessel Disease, Osijek University Hospital. The research was approved by the Ethics Committee of the Medical Faculty Osijek and the Ethics Committee of the Osijek University Hospital.

Demographic and clinical data were collected from the pts 'medical histories in the available medical records (electronic database). The inclusion criteria for the study was diagnosis of HFrEF according to hospital discharge letter, diagnosis made according to recent European Cardiology Guidelines for Heart Failure, 2016. The exclusion criteria for the study were diagnosis of heart failure with preserved ejection fraction, unclear diagnosis and incomplete medical documentation.

The parameters used in the research include age, gender, etiology of HFrEF, biochemical parameters: electrolytes – sodium and potassium, renal function parameters – urea and creatinine, complete red blood count – erythrocytes, hemoglobin, hematocrit and MCV, C-reactive protein, troponin I, NTproBNP; electrocardiographic data (ECG) – sinus rhythm or atrial fibrillation with the frequency data; echocardiographic parameters provided in routine clinical practice according to European Association of Cardiovascular Imaging recommendation: left ventricle ejection fraction – LVEF, left ventricle and left atrium diameters, stage of the diastolic dysfunction; comorbidities data.

The pts with HFrEF were divided into two groups according to the number of hospitalizations because of HFrEF worsening, first hospitalization and rehospitalization. The general, biochemical, hemodynamic and echocardiographic parameters were analyzed in both groups and HFrEF pts.

Categorical data were presented in terms of absolute and relative frequencies. Differences in categorical variables were tested via Fisher's exact test. The normality of the distribution of the numerical variables was tested via the Shapiro-Wilk test. Numerical data are described via the median and the limits of the interquartile range. The differences in the numerical variables between the two independent groups were tested via the Mann-Whitney U-test. The correlation between the variables was assessed via the Spearman correlation coefficient (Rho). All P-values are two-sided. The significance level was set to Alpha = 0.05. MedCalc Statistical Software Version 19.1.7 (MedCalc Software Ltd, Ostend, Belgium; https://www.medcalc.org; 2020) was used for statistical analysis.

Results

The study included 50 adult pts of both sexes, of whom 70% were male and 30% were female. These pts were di-

vided into two groups based on the number of previous hospitalizations. The first group consisted of the 42% of patients for whom this was the first hospitalization, while the second group consisted of the 58% who were hospitalized more than once. The median age for all pts was 76 years old (interquartile range 66 to 82 years). At the first hospitalization, the median age was 79, and at repeated hospitalization, the median age was 70 years old. Male pts were younger in both groups (first hospitalization at 78 years old, repeated hospitalization at 68,5 years old), and females were older in both groups (first hospitalization at 81.5 years old, repeated hospitalization at 80 years old).

The most common HFrEF etiologies included HTA (82% pts), CHD (54%) and DM (40% pts), regardless of whether this was the patients' first hospitalization or a rehospitalization. Regarding the causes of HFrEF, 24% of pts had severe aortic valve stenosis, and 14% had severe mitral regurgitation. Among included pts, CHD was treated with percutaneous coronary intervention (PCI), coronary artery bypass grafting (CABG) and optimal medical therapy. Serious arrythmias were treated with implantable cardiac devices, such as pacemakers, cardioverter defibrillators and cardiac resynchronization therapy defibrillators (Table 1). The most common comorbidity was COPD, which presented in 20% pts, regardless of whether they were hospitalized for the first time or rehospitalized. The percentage of pts with pneumonia was significantly higher in those who were hospitalized for the first time, P=0.03 (Table 1).

The median systolic blood pressure at the first hospitalization was 128 mmHg, while at repeated hospitalization, this value was 120 mmHg, with P=0.10. There were no changes in diastolic blood pressure regardless of the number of hospitalizations, and the median value was 70 mmHg. Patients hospitalized for the first time had significantly higher heart rates than rehospitalized pts (P = 0.04), with a median of 94 (interquartile range of 83 to 114). Markers of cardiac ischemia, specifically troponin I, showed no significant correlation at this sample size, but the P-value was 0.10. A marker of heart failure, NTproB-NP, showed increased values at rehospitalization in terms of total numbers, but this was without statistical significance (Table 2, Figure 1, Figure 2).

Echocardiographic data showed significant results in terms of their use as prognostic parameters in rehospitalized pts. Endsystolic LV diameter was significantly dilated in pts who underwent repeated hospitalization (P=0.003), and the degree of diastolic dysfunction was significantly higher in rehospitalized pts as compared to pts hospitalized for the first time (P=0.04). At this sample size, end diastolic LV diameter and LA diameter showed no significant correlation, but there were p-values 0.09 for end diastolic LV diameter and 0.08 for LA diameter (Table 3).

TABLE 1

CHARACTERISTICS OF HOSPITALIZED PATIENTS WITH HFrEF

1st hospitalization		Number of subjects (%)			
		1st hospitalization	Rehospitalization	Total	P*
Gender	Male	13 (62)	22 (76)	35 (70)	0 .36
	Female	8 (38)	7 (24)	15 (30)	0 .36
Diabetes mellitus		8 (38)	12 (41)	20 (40)	>0 .99
Arterial hypertension		19 (91)	21 (75)	40 (82)	0 .27
Coronary heart disease (CHD)		13 (62)	14 (48)	27 (54)	0 .40
Atrial fibrillation		11 (42)	15(57)	26 (52)	>0 .99
CHD treatment method	Percutaneous coronary intervention (PCI)	2/13	6/14	8/27	0 .31
	Medical therapy	7/13	4/14	11/27	0 .31
	Coronary artery bypass grafting (CABG)	4/13	4/14	8/27	0 .31
Aortic valve stenosis (gravis)		3 (14)	9 (31)	12 (24)	0 .20
Mitral regurgitation (gravis)		4 (19)	3 (10)	7 (14)	0 .43
Electrostimulation		3 (14)	9 (31)	12 (24)	0 .20
Electrostimulation method	Implantable cardioverter-difibrillator (ICD)	2/3	4/9	6/12	> 0 .99
	Pacemaker	1/3	4/9	5/12	> 0 .99
	Cardiac resyncronisation therapy defibrillator (CRT-D)	0/3	1/9	1/12	> 0 .99

*Fisher's exact test; HFrEF – heart failure with reduced ejection fraction

TABLE 2

COMORBIDITIES OF HOSPITALIZED PATIENTS WITH HFrEF

	Number of subjects (%)			
	1st hospitalization	Rehospitalization	Total	P*
Non-Hodgkin lymphoma	0	1 (3)	1 (2)	> 0 .99
Breast cancer	2 (9)	0	2 (4)	0 .17
Prostate cancer	0	2 (7)	2 (4)	0 .50
Chronic obstructive pulmorary disease	3 (14)	7 (24)	10 (20)	0 .49
Pulmonary silicosis	0	1 (3)	1 (2)	>0 .99
Gastritis	0	1 (3)	1 (2)	>0 .99
Cerebrovascular insult	2 (9)	4 (14)	6 (12)	>0 .99
Anemia	1 (5)	2 (7)	3 (6)	>0 .99
Periferal arterial disease	0	2 (7)	2 (4)	0 .50
Urinary bladder cancer	0	1 (3)	1 (2)	>0 .99
Pneumonia	4 (19)	0	4 (8)	0 .03†
Rheumatoid arthritis	1 (5)	0	1 (2)	0 .42
Internal carotid arterry stenosis	0	1 (3)	1 (2)	>0 .99
Hyperthyreosis	0	1 (3)	1 (2)	>0 .99
Colon polypes	0	1 (3)	1 (2)	>0 .99
Abdominal aortic aneurysm	1 (5)	0	1 (2)	0 .42
Nephrectomy	0	1 (3)	1 (2)	>0 .99
Thromboembolism	0	1 (3)	1 (2)	>0 .99
Pulmonary thromboembolism	0	2 (7)	2 (4)	0 .50
Deep vein thrombosis	0	1 (3)	1 (2)	>0 .99
Collagenosis	0	1 (3)	1 (2)	>0 .99
Basal-cell carcinomas	0	1 (3)	1 (2)	>0 .99

*Fisher's exact test; † results with statistical significance; HFrEF – heart failure with reduced ejection fraction

Atrial fibrilliation was present in 52% of pts, and sinus rhythm was present in 48% of pts, regardless of whether it was their first hospitalization or a rehospitalization. Rehospitalized pts with AF had significantly lower values for LVEF than pts hospitalized for the first time (P=0.03) (Figure 3).

This study did not find significant differences in biochemical blood analysis (complete blood count, electrolytes, renal function and inflammatory markers) (Table 2).

Discussion

HF is the most prominent cause of hospitalization globally[2,12]. The rehospitalization burden in HFrEF pts remains very high, with poor quality of life, increased mortality and large healthcare expenditures[13]. In the HF population, noncardiac comorbidities often coexist and have an adverse effect on outcome. The prevalence and prognostic impact of noncardiac comorbidities in pts with

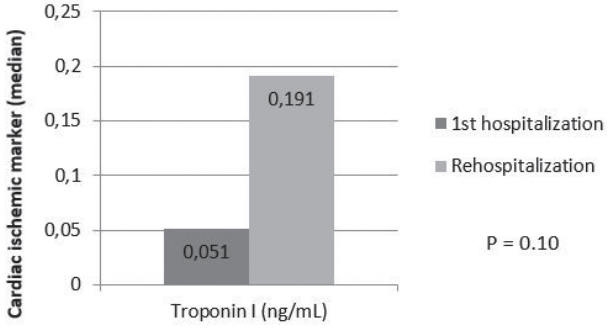

Fig. 1. Troponin I level in in first and repeated hospitalization in HFrEF patients.

HFrEF – heart failure with reduced ejection fraction.

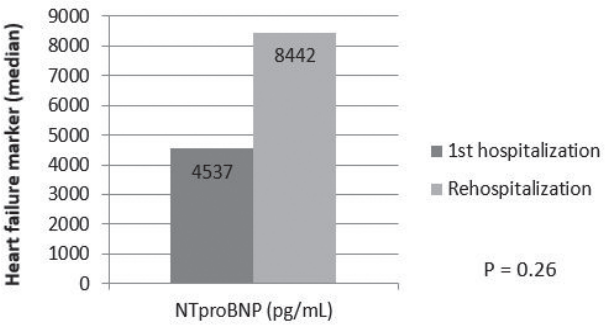

Fig. 2. NTproBNP level in first and repeated hospitalization in HFrEF patients. NTproBNP - N-terminal pro b-type natriuretic peptide; HFrEF – heart failure with reduced ejection fraction.

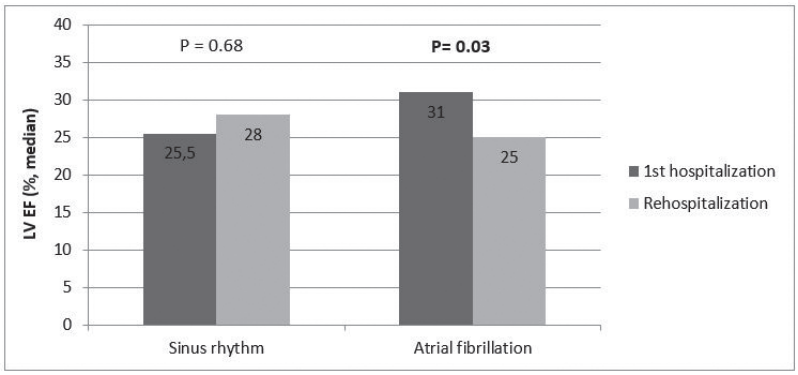

Fig. 3. The difference in NTproBNP level in first and repeated hospitalization, in HFrEF patients with sinus rhythm and atrial fibrillation. HFrEF – heart failure with reduced ejection fraction

HFrEF remain inadequately studied[14]. Across all comorbidities examined in trials with HF, data were reported for a mean of 35% of trials (51% in HFrEF trials and 27% in HFpEF trials). Among cardiac comorbidities, the most important were HTA (63%), CHD (44%), hyperlipidaemia (48%), DM (33%) and AF (25%), while the most important noncardiac comorbidity was chronic kidney disease (CKD) (25%). Many HF trials do not report baseline comorbidi-

TABLE 3

BIOCHEMICAL, HAEMODINAMIC AND ECHOCARDIOGRAPHIC PARAMETERS OF HOSPITALIZED PATIENTS WITH HFrEF

1st hospitalization		Median (interquartile range)		
		Rehospitalization	P*	
Red blood count	erythrocytes	4.32 (4.1–4.8)	4.46 (4.1–4.96)	0.86
	hemoglobin	138 (117.5–147.5)	134 (119.5–146)	0.52
	Hematocrit	0.41 (0.4–0.4)	0.4 (0.36–0.43)	0.55
	MCV	90.1 (83.6–95.8)	87.2 (84.1–89.6)	0.20
Electrolytes	sodium	139 (137.5–140.5)	139 (134–141)	0.40
	potassium	4.3 (3.8–4.6)	4.2 (4–4.6)	0.59
Renal function	urea	7.9 (5.8–12.1)	8.4 (7.3–13.4)	0.37
	creatinine	93 (77–139)	98 (82.5–135)	0.81
C-reactive protein		12.2 (3.9–38.2)	7.7 (3.4–17.4)	0.21
Blood pressure	Systolic	128 (110–158)	120 (106.5 – 130)	0.09‡
	Diastolic	70 (67–100)	70 (63 – 80)	0.38
ECG	Heart rate	100 (92–121)	90 (71 – 109)	0.04†
Troponin I		0.051 (0.024–0.186)	0.191 (0.041 – 0.554)	0.10‡
NTproBNP		4537 (3091–10469)	8442 (2935.5 – 17144)	0.26
Echocardiographic indicators – 2D TTE	LVEF	30 (25–35)	27 (21–32)	0.18
	EDD LV	56 (49.5–60)	59.5 (54.3–63.8)	0.09‡
	ESD LV	46 (40–50)	51 (49–55)	0.003†
	DD degree	1 (1–2)	2 (2–2)	0.04†
	TAPSE	16.5 (13.3–19.8)	14 (12–17)	0.16
	LA	48.5 (44.5–50.3)	51 (46.3–56.8)	0.08‡

*Mann Whitney U test; † results with statistical significance; ‡ results without statistical significance, but with $p \leq 0.10$

HFrEF – heart failure with reduced ejection fraction; 2D TTE – two dimensional echocardiographic parameters; ECG – electrocardiogram; NTproBNP – N-terminal pro b-type natriuretic peptide; LVEF – left ventricle ejection fraction; EDD LV – left ventricle enddiastolic diameter; ESD LV – left ventricle endsystolic diameter; DD – diastolic dysfunction; TAPSE – tricuspid annular plane systolic excursion; LA – parasternal left atrial diameter;

ties. A more systematic approach must be adopted for future clinical trials to ensure adequate cardiac and noncardiac comorbidity reporting and improve the recruitment of multimorbid HF pts[14].

The data in our study are in line with those of previous studies. HF rarely occurs as an isolated case. The most common cardiac and noncardiac comorbidities include HTA, CHD, DM, AF, CKD and COPD. Although no statistical significance has been proven in relation to whether this is the first hospitalization or rehospitalization, the incidence rates for HTA, CHD, DM and AF are even higher in our study than those previously reported[3]. In our study, 82% of all pts were diagnosed with HTA. Although HTA is one of the most common comorbidities associated with HF, according to the latest European Cardiac Guidelines, it is usually well regulated in treated pts[1]. CHD is the next most common comorbidity, leading to a worse prognosis and poorer outcomes than in pts without CHD. Our results are in line with a study conducted on 1,200 pts diagnosed with HFrEF, which showed that the mortality rate was high, regardless of whether this condition was treated with conservative drugs or combined invasive therapy (68% versus 58%)[15]. DM was the third most common comorbidity in the study (40%). Unregulated DM increases the number of hospitalizations and negatively affects HF, which is in line with a study conducted on 2,500 pts, in which an increase in HbA1c above 8.6% caused a 36.2% increase in hospitalizations[16]. Atrial fibrillation was present in 52% of HFrEF pts at the first hospitalization, with significantly better LVEF as compared to rehospitalized pts with AF and a lower degree of LVEF. The results obtained indicate that prolonged AF, along with other comorbidities, leads to worsening LVEF and thus worsening outcomes for HF. Rehospitalized HFrEF pts had significantly lower heart rates as compared to those hospitalized for the first time. The cause of this may be the sinus atrial node being affected by myocardial disease, or it could be a result of HFrEF treatment. The goal of treatment for these pts is to return to a proper heart rate[17]. As a marker of HF, NTproBNP is used as an initial tool for performing diagnosis, disease graduation and follow up. The results of the study did not prove a statistically significant difference in the number of hospitalizations between the groups, although rehospitalized pts had higher NTproBNP values as compared to first-time hospitalizations, indicating the greater impairment of systolic and diastolic function in rehospitalized pts[18]. This was also indicated by the results obtained via further echocardiographic processing. Rehospitalized pts had significantly higher LV diameter values during systole and a significantly higher degree of diastolic dysfunction than those hospitalized for the first time[19,20]. HF is a disease that primarily affects the elderly population. One such cohort study was conducted in Rotterdam on around 8,000 pts who were hospitalized with a diagnosis of HF.

This study demonstrated an increase in prevalence in proportion to the increase in the age of pts, from 0.9% between the ages of 55 and 64 to almost 10% between the ages of 75 and 84. The average age of the pts in the study was 74.5 years, and HF affected men slightly more frequently than women[21]. COPD is present in 20% of pts and is more common in pts diagnosed with HF than in healthy people. This is line with the Cardiovascular Health study that in a sample of almost 5,000 subjects, obtained similar results[22]. The symptoms and signs of COPD are often intertwined with the clinical picture of HF, making it difficult to perform a diagnosis. Pneumonia occurs significantly more frequently in pts hospitalized for the first time as opposed to rehospitalized pts (19%). These pts also had slightly higher CRP values than those hospitalized multiple times, although not significantly so. However, pneumonia may not be the only cause of this elevated marker of inflammation[23]. Other examined biochemical parameters, such as renal function and complete blood count, did not show any significance in our study, which may be due to the duration and the course of the comorbidities and disease.

Conclusion

In this retrospective HFrEF analysis, we have seen that cardiac comorbidities in our population have even higher incidence than previously reported, which is directly related with the risk of the first hospitalization, together with gender and age. Noncardiac comorbidities have an important role in HFrEF manifestation and time to repeated hospitalization, which is directly related with the progressive decay of HF stage. In this group of pts, pnemonia was important for the first hospitalization, and COPD is the most common noncardiac comorbidity regardless of the number of hospitalizations. Echocardiographic parameters related to morphologic, functional and hemodinamic changes caused by cardiac and noncardac diseases are crucial to HFrEF rehospitalization risk. Our study has several limitations: the number of included pts, the data obtained from the medical files, limited information on the degrees and duration of the comorbidities.

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PROGNOSTIČKI POKAZATELJI PRVE I PONOVLJENE HOSPITALIZACIJE KOD PACIJENATA SA SRČANIM ZATAJIVANJEM S REDUCIRANOM EJEKCIJSKOM FRAKCIJOM LIJEVE KLIJETKE

S A Ž E T A K

Srčano popuštanje s reduciranom ejekcijskom frakcijom (HFrEF) progresivni je klinički sindrom definiran strukturnim promjenama miokarda koji dovodi prvenstveno do oštećenja sistoličke funkcije s redukcijom ejekcijske frakcije lijeve klijetke ≤40 %. Učestalost ponovne hospitalizacije pacijenata s HfrEF-om vrlo je visoka, smanjuje kvalitetu života, povećava stopu smrtnosti i veliko je financijsko opterećenje zdravstvenome sustavu. U istraživanju su proučavani rizični čimbenici za prvu i ponovnu hospitalizaciju kod pacijenata s HfrEF-om. U ovu retrospektivnu studiju uključeno je 50 odraslih pacijenata s dijagnozom HfrEF-a, životne dobi između 55 i 89 godina, oba spola. Demografski i klinički podaci (etiologija HfrEF-a, parametri bubrežne funkcije, kompletna krvna slika, biljezi upale, elektrokardiogram, troponin I, NTproBNP, ehokardiografski parametri, komorbiditeti) prikupljeni su iz medicinske dokumentacije pacijenata. Statistička analiza učinjena je Fischerovim egzaktnim testom, Shapiro-Wilk testom i Spearmanovim koeficijentom korelacije. U studiju je uključeno 70% muškaraca i 30% žena s HfrEF-om, muškarci su u obje praćene skupine bili mlađe životne dobi te su imali veću incidenciju rehospitalizacije. Najznačajniji etiološki čimbenici rizika za HFrEF su arterijska hipertenzija (82%), koronarna bolest (54%), atrijska fibrilacija (52%), šećerna bolest (40%). Od nekardioloških komorbiditeta vezanih uz prvu hospitalizaciju pacijenata s HfrEF-om najznačajnija je pneumonija (P = 0,03), dok je pogoršanje sistoličke i dijastoličke funkcije lijeve klijetke vezano uz ponovnu hospitalizaciju (end-sistolički promjer lijeve klijetke, P = 0,003; stupanj dijastoličke disfunkcije, P = 0,04). Biomarker troponin I pokazao je tendenciju porasta u rehospitalizaciji, ali bez statističke značajnosti na ovoj veličini uzorka (troponin I, p = 0,10). Komorbiditeti, starenje i spol ključni su za razvoj HFrEF-a, dok su ehokardiografski parametri i biomarkeri ključni za rehospitalizaciju.