Treatment characteristics and factors associated with heart failure with improved ejection fraction in the heart failure patient management program at Hanoi Heart Hospital

Vu Quynh Nga ✉, **Tran Thanh Hoa, Nguyen Thi Quynh Trang**

Hanoi Heart Hospital

Correspondence to
Dr. Vu Quynh Nga
Hanoi Heart Hospital
Email: ngavuq@gmail.com

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ABSTRACT

Background: Many patients with heart failure (HF) with reduced ejection fraction (HFrEF) have improved or restored left ventricular ejection fraction (LVEF). Within context heart failure with recovered or improved ejection fraction (HFiEF) has been proposed as a new category of HF. Data on clinical characteristics, outcomes, and medical, interventional, surgical, or related factors in patients with heart failure with improved ejection fraction (HFiEF) are scarce.

Methods: Descriptive analysis study, the period from May 2021 to November 2022 satisfies the criteria for heart failure with reduced or slightly reduced ejection fraction and is hospitalized for inpatient treatment, discharged from the hospital to participate in the patient management program heart failure for at least 3 months.

Results: 488 patients were included in the study, the average age of the improved group and the remaining group were 64.35±13.74 and 64.39±13.55, the proportion of women in the improvement group and the remaining group are 50% and 41.6%. The rate of use of RAS system drugs and beta blockers improved by 96.4% and 89.3%, respectively, higher than the other group's 86.1% and 74.5%, which is statistically significant. The rate of MRA, SGLT2-i in the improved group and the remaining group was 63.1%; 59.5% and 64.9%; 61.9%. The rate of using 2 drugs including RAS and beta blockers in the improvement group (85.7%) was statistically significantly higher than the other group (67.6%). The area under the ROC curve of admission EF, LVEDVi, LVESVi in predicting improvement was 0.687 (95% CI 0.640-0.730; p< 0.001), respectively; 0.531(95% CI 0.462-0.599; p=0.378); 0.543 (95% CI 0.467-0.611; p=0.211). If only calculated on the total number of patients with EF ≤ 40%, the Kaplan Meier chart of CABG, heart valve surgery and percutaneous coronary intervention predicting improvement in heart failure after 3 months are all statistically significant.

Conclusion: The rate of heart failure improved in the program was 17.2%. EF at admission, rate of use of RAS system drugs, beta blockers, rate of use of 2 RAS system drugs and beta blockers, percutaneous

coronary intervention, CABG surgery or Heart valve surgery is significant in predicting improved heart failure in the heart failure program at Hanoi Heart Hospital.

Keywords: heart failure, guidelines, heart failure outpatient program, heart failure improved ejection fraction.

INTRODUCTION

Heart failure is characterized by multiple relapses, with an expected one-year hospital readmission rate of over 50% and a one-year mortality rate of over 30%[1;2]. Outpatient management for heart failure patients is multimodal and includes several steps listed in the American College of Cardiology/American Heart Association (ACC/AHA) Heart Failure Management Guidelines[3].

Many patients with reduced ejection fraction heart failure (HFrEF) have improved or recovered left ventricular ejection fraction (LVEF). In the context of improved ejection fraction, it has been proposed as a new type of heart failure. Data on clinical characteristics, outcomes and medical, interventional, surgical treatment or related factors in patients with improved ejection fraction heart failure (HFiEF) are still scarce. We conducted a study with the goal of:

Determining the clinical, subclinical characteristics and treatment characteristics of patients with improved ejection fraction heart failure in the Hanoi Heart Hospital heart failure patient management program.

SUBJECTS AND METHODS

Inclusion criteria: Patients with reduced or mildly reduced ejection fraction heart failure who were hospitalized for inpatient treatment, discharged and participated in the Hanoi Heart Hospital heart failure management program continuously for at least 3 months.

Study period: From May 2021 to November 2022.

Method: Cross-sectional, prospective analysis.

Variables:

Collecting data according to a unified sample of eligible patients who underwent inpatient treatment and data on participation in the outpatient heart failure management program.

Patients enrolled in the Heart Failure Management Program from May 2021 to November 2022, the time of enrollment in the study did not start at the same time, however at the time the patient was admitted was considered the initial follow-up time. Excluding patients who were not followed up for at least 3 months in the Heart Failure Management Program.

Clinical symptoms of heart failure according to NYHA classification, HA parameters, heart rate at each follow-up.

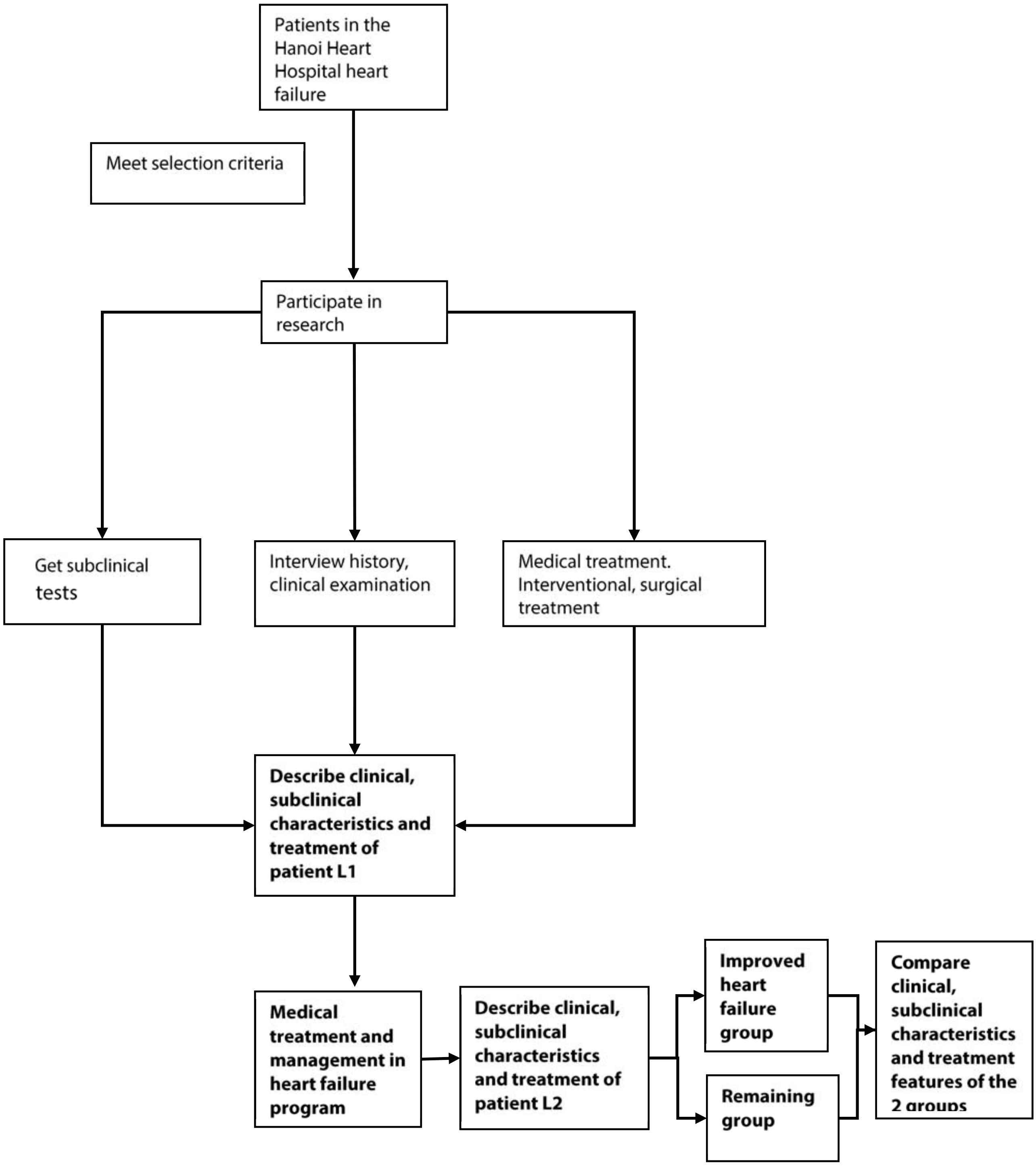
Investigating comorbidities or medical history (localized ischemic heart disease, hypertension, atrial fibrillation, stroke history, diabetes,, heart valve disease, chronic lung disease, dilated cardiomyopathy, hypertrophic cardiomyopathy, congenital heart disease, pacemaker implantation, heart surgery), current medications (digoxin, diuretics, ACE inhibitors, ARBs, beta-blockers, aldosterone antagonists, SGLT2 inhibitors, etc.), medication compliance (regular, irregular, non-adherent), changes in medications at each follow-up timepoint.

Recording echocardiogram results assessing left ventricular end-diastolic diameter (Dd), end-systolic diameter (Ds), calculating ejection fraction (EF), estimating pulmonary artery systolic pressure. Recording electrocardiogram results and blood tests during follow-up.

Collecting data on medication use: drug name, dosage, combination of heart failure drugs for each patient within 12 months at timepoints: initial follow-up, 1 week, 1 month, 3 months, 6 months, 12 months of treatment in the heart failure program.

Collecting data on causes of hospitalization, triggering factors for acute heart failure exacerbations in patients (if any).

Study schema:



L1: Timepoint of inpatient treatment, initial study timepoint.

L2: Timepoint after 3 months since discharge.

Statistical Analysis: Described as percentage for categorical variables, mean ±SD for quantitative variables; All collected data were stored and analyzed using SPSS 24.0 statistical software; The collected data of the study were processed according to medical statistical algorithms using STATA 12.0 software; Mann–Whitney U tests and Kruskal-Wallis analysis of variance (ANOVA) tests were used as appropriate nonparametric parameter tests and a p value <0.05 was considered significant.

Research Ethics: Obtained patient consent, patient information was kept confidential and study results were for scientific research purposes.

Here is my translation of the Vietnamese results section into English:

RESULTS

From May 2021 to November 2022, 488 patients were included in the study, of which 84 patients had improved ejection fraction heart failure after 3 months, accounting for 17.2%. The average age of the improved group and remaining group was 64.35±13.74 and 64.39±13.55, respectively; the proportion of females in the improved group and remaining group was 50% and 41.6%, respectively. The patients were divided into 2 groups for comparison: improved group and remaining group. We have the following observations:

***Table 3.1**. Epidemiological characteristics and causes of heart failure*

	Improved heart failure group		Remaining group		p
	n	%	n	%	
Epidemiological, clinical characteristics					
Female	42 (50.0)		168(41.6)		0.098
Male	42 (50.0)		236(58.4)		
Age (M±SD)	64.35±13.74		64.39±13.55		0.551
Comorbidities					
Hypertension	45	54.2	222	55.0	0.498
Type 2 diabetes	24	28.6	117	29.0	0.529
Chronic kidney disease	11	13.1	75	18.6	0.149
COPD or asthma	**2**	**5.9**	**24**	**2.4**	**0.043**
Main causes of heart failure					
Ischemic heart disease	**40**	**47.6**	**203**	**50.4**	**0.046**
Dilated cardiomyopathy	23	27.4	102	25.2	0.956
Valvular heart disease	21	25.0	97	24.0	
Chemotherapy-induced cardiomyopathy	0	0	1	0.2	
Hypertrophic cardiomyopathy	0	0	1	0.2	

Observations: There was no difference in gender, age, risk factors of alcohol drinking or smoking between the two groups; comorbidities such as hypertension, type 2 diabetes, chronic kidney disease were higher in the remaining group but without statistical significance compared to the improved group; the common causes of heart failure were ischemic heart disease, dilated cardiomyopathy and then valvular heart disease.

***Table 3.2**. Characteristics of rehospitalization*

	Improved heart failure group		Remaining group		p
	n	%	n	%	
Rehospitalization within 1 year	**8**	**9.5**	**82**	**20.3**	**0.012**
Number of rehospitalizations within 30 days (M±SD) (min-max)	0.01±0.11		0.06±0.29		0.177
Number of rehospitalizations within 1 year (M±SD) (min-max)	**0.14±0.49**		**0.29±0.74**		**0.043**

Observations: The improved group had a statistically significantly lower rate of rehospitalization and number of rehospitalizations within 1 year compared to the remaining group.

Table 3.3. Clinical and subclinical characteristics

		Improved heart failure group	Remaining group	p
Clinical characteristics				
Heart rate_1 (M±SD)		77.62±11.75	78.84±16.69	0.605
SBP_1 (M±SD)		**88.52±18.96**	**90.27±21.57**	**0.035**
Subclinical characteristics				
NT proBNP 1 (M±SD)		6929.80±8756.24	5413.12±6996.60	0.294
Troponin Ths 1(M±SD)		271.28±941.08	499.09±1245.66	0.208
Creatinine 1(M±SD)		88.97±31.68	105.13±51.51	0.115
Hb 1(M±SD)		136.54±19.15	133.534±20.47	0.221
LDL 1(M±SD)		**1.57±0.84**	**1.405±0.74**	**< 0.001**
Echocardiogram characteristics				
EF_1(M±SD)	**EF(M±SD) (min-max)**	**32.23±5.55**	**37.62±8.73**	**< 0.001**
	EF ≤ 30%	**32(38.1)**	**122 (27.7)**	**< 0.001**
	30%< EF ≤ 40%	**52(61.9)**	**128 (31.7)**	
	EF > 40%	**0**	**164 (40.6)**	
LVEDVi_1(M±SD)		141.12±41.73	146.78±49.69	0.469
LVESVi_1(M±SD)		75.31±36.27	82.84±45.64	0.302

Observations: Systolic blood pressure was lower and LDL was higher with statistical significance in the improved heart failure group compared to the remaining group.

Table 3.4. Characteristics of guideline-directed medical therapy

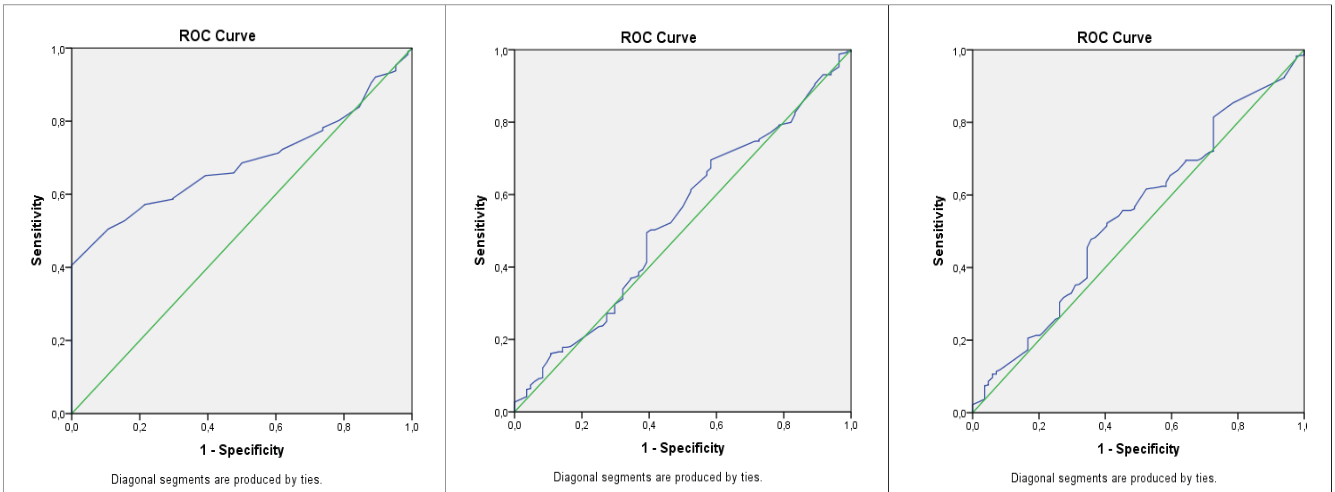
	Improved heart failure group		Remaining group		p
	N=84	%	N=404	%	
1-drug therapy					
ARNI/ARB/ACEI	**81**	**96.4**	**348**	**86.1**	**0.004**
Beta-blocker	**75**	**89.3**	**301**	**74.5**	**0.004**
MRA	53	63.1	262	64.9	0.279
SGLT2i	50	59.5	250	61.9	0.354
2-drug therapy					
ARNI/ARB/ACEI + beta-blocker	**72**	**85.7**	**273**	**67.6**	**< 0.001**
ARNI/ARB/ACEI + MRA	50	59.5	234	57.9	0.442
ARNI/ARB/ACEI + SGLT2i	49	58.3	236	58.4	0.541
MRA + beta-blocker	47	56.0	215	53.2	0.369
MRA + SGLT2i	36	42.9	187	46.3	0.326
Beta-blocker + SGLT2i	46	54.8	195	48.3	0.168
3-drug therapy					
ARNI/ARB/ACEI + beta-blocker + MRA	44	52.4	199	49.3	0.344
ARNI/ARB/ACEI + beta-blocker + SGLT2i	45	53.6	189	46.8	0.155
Beta-blocker + MRA + SGLT2i	47	56.0	215	53.2	0.369
4-drug therapy					
ARNI/ARB/ACEI + beta-blocker + MRA + SGLT2i	32	38.1	153	37.9	0.531

Observations: The rates of using RAS system and beta-blocker drugs, or the rate of using both drugs, were statistically significantly higher in the improved group compared to the remaining group.

***Table 3.5**. Characteristics of achieving half target dose of guideline-directed medical therapy*

		Improved heart failure group (%)	Remaining group (%)	p
RAS inhibitors	ARNI	15.4	24.6	0.002
	AECI	**7.2**	**1.4**	**0.02**
	ARB	**40.4**	**23.7**	**0.04**
	Total	**63**	**49.7**	**0.032**
Beta-blocker		34.5	31.9	0.505
MRA		**30.9**	**39.3**	**0.001**

Observations: The rate of achieving half the target dose for RAS system drugs was statistically significantly higher in the improved group compared to the remaining group.



ROC curve of admission EF: AUC=0.687; 0.640-0.730; p < 0.001

ROC curve of LVEDVi: AUC=0.531; 0.462-0.599; p=0.378

ROC curve of LVESVi: AUC=0.543; 0.467-0.611; p=0.211

***Figure 3.1**. Area under the ROC curve (AUC) to predict improved ejection fraction heart failure of EF, LVEDVi, LVESVi*

Observations: The AUC of EF had statistical significance in predicting improved ejection fraction heart failure.

***Table 3.6**. Univariate and multivariate analysis to predict improved ejection fraction heart failure*

	HR	95% CI	p	HR	95%CI	p
	Univariate model			Multivariate model		
Admission SBP	**1.016**	**1.006-1.026**	**0.001**	**1.014**	**1.004-1.024**	**0.007**
Admission EF	**0.936**	**0.913-0.960**	**< 0.001**	**0.936**	**0.909-0.963**	**< 0.001**
PCI performed	0.729	0.426-1.249	0.250			
AF ablation performed	1.358	0.763-2.417	0.298			
ICD implanted	0.340	0.047-2.463	0.286			

	HR	95% CI	p	HR	95%CI	p
	Univariate model			Multivariate model		
Surgery performed	**2.403**	**1.330-4.334**	**0.004**	**0.695**	**0.344-1.404**	**0.031**
Rehospitalization within 1 year	**2.493**	**1.202-5.172**	**0.014**	0.503	0.233-1.083	0.079
Ventilated	**0.398**	**0.232-0.683**	**0.001**	**0.675**	**0.361-1.262**	**0.021**

Observations: In univariate models for predicting improved heart failure, admission systolic blood pressure, admission EF, surgery, rehospitalization within 1 year, and ventilation during first admission had statistical significance. In multivariate models, only admission EF, surgery, and ventilation remained statistically significant.

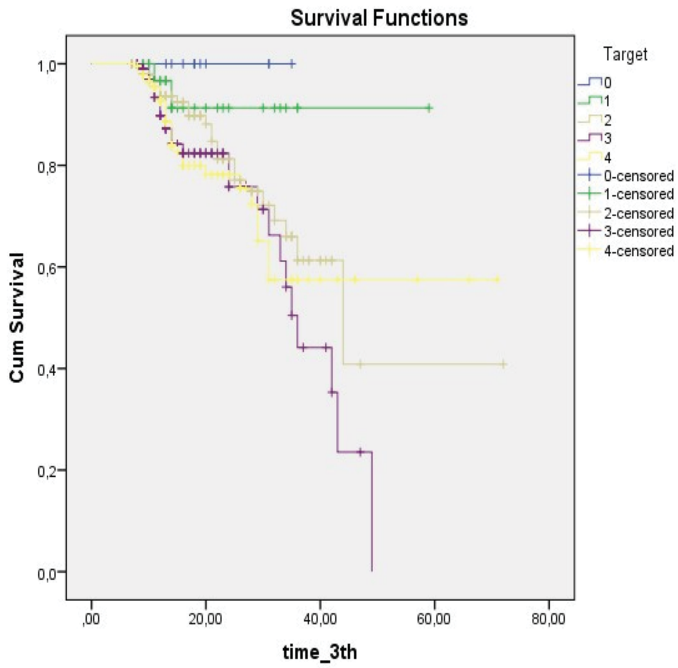


***Figure 3.2**. Kaplan-Meier curves for use of 1, 2, 3, and 4 drugs in predicting improved ejection fraction heart failure*

Observations: Kaplan-Meier curves predicting improved heart failure after 3 months based on use of 2, 3, or 4 drugs had statistical significance (p 1 drug = 0.178; p 2 drugs = 0.01; p 3 drugs = 0.02; p 4 drugs = 0.01). There were significantly more patients with improvement when using 3 drugs.

***Table 3.7**. Characteristics of interventions and surgery in reduced ejection fraction heart failure patients*

	Improved heart failure group		Remaining group		p
	N	%	n	%	
Intervention characteristics					
Percutaneous coronary intervention (PCI)	18	21.4	47	19.6	0.32
Atrial fibrillation ablation	2	2.4	4	1.7	0.49
CRT device implantation	0	0	0	0	
ICD device implantation	1	1.2	2	0.8	0.43
Surgical treatment					
CABG	**9**	**10.7**	**12**	**5.0**	**0.049**

	Improved heart failure group		Remaining group		p
	N	%	n	%	
Mitral valve replacement	**6**	**7.1**	**12**	**5.0**	**0.03**
Aortic valve replacement	**3**	**3.6**	**4**	**1.7**	
Double valve (mitral + aortic) replacement	**4**	**4.8**	**4**	**1.7**	
Other treatments					
Hemodialysis	0	0	2	0.8	0.567
Mechanical ventilation	**18**	**21.4**	**34**	**14.2**	**0.008**

Observations: In patients with EF ≤ 40%, the rates of CABG, valve surgery were higher and ventilation was lower in the improved group, with statistical significance for all.

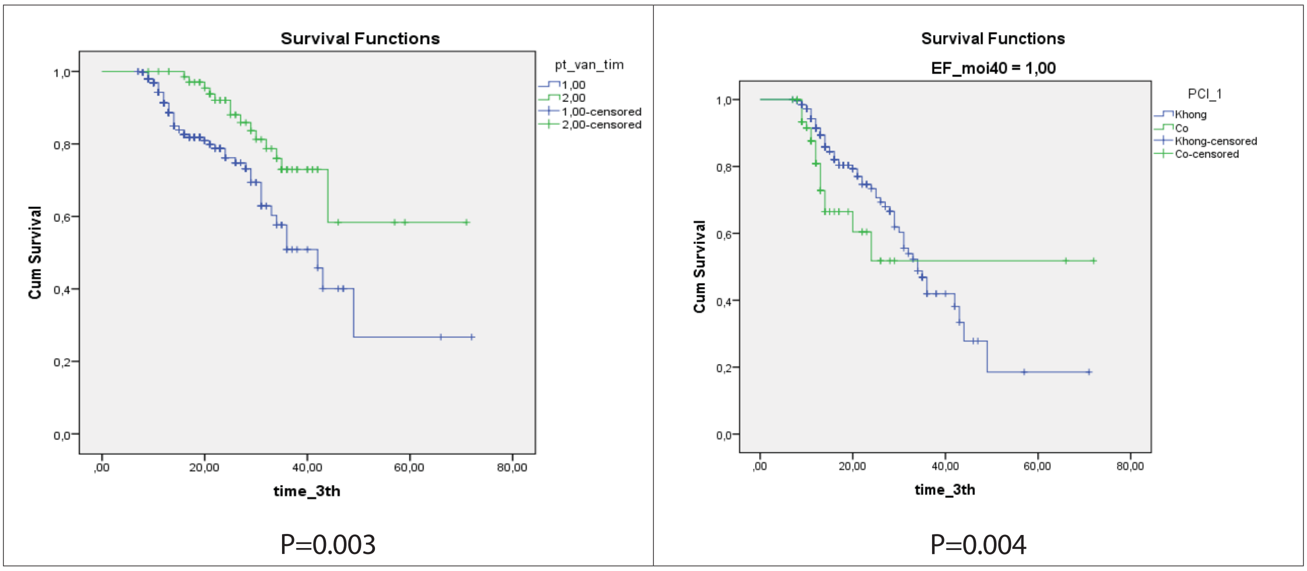


***Figure 3.3**. Kaplan-Meier curves for valve surgery and PCI in predicting improved ejection fraction heart failure.*

Observations: In patients with EF ≤ 40%, Kaplan-Meier curves predicting improved heart failure after 3 months for valve surgery and PCI both had statistical significance.

DISCUSSION

Epidemiological, clinical and subclinical characteristics

In our study, the mean age of the improved and remaining groups was 64.35±13.74 and 64.39±13.55 respectively; the proportion of females in the improved and remaining groups was 50% and 41.6% respectively. Compared to the study by Viorel et al. on a total of 3519 patients: the age of the improved and remaining groups was 61±11 and 62±11 respectively; females in the improved and remaining groups were 26% and 20% respectively; their age was lower than our study, and the proportion of females was also lower. Or when compared to Chan Soon Park et al. on 1509 patients: the age of the improved and remaining groups was 59.5±15.8 and 65.0±14.1 respectively; females in the improved and remaining groups were 41.5% and 34.6% respectively, noting that in the improved group, our age and proportion of females was higher.[4;5]

The rate of comorbidities in our study was highest for hypertension and type 2 diabetes, with rates in the improved and remaining groups of 54.2%; 28.6% and 55%; 29% respectively, with no statistically significant difference between the two groups. This rate is higher than in the study by Viorel et al: 12%; 24% and 6%; 25% respectively; meanwhile, the rate of hypertension was lower in the study by Chan Soon Park et al: 48.3%; 51.8%; the rate of type 2 diabetes was higher in the improved group (24.4%) and lower in the remaining group (40.4%).[4;5]

The most common cause in both groups was ischemic heart disease, with rates in the improved and remaining groups of 47.6% and 50.4% respectively, significantly higher in the improved group. This was followed by high rates of dilated cardiomyopathy and valvular heart disease, with rates in the improved and remaining groups of 27.4%; 25% and 25.2%; 24% respectively. This once again shows the changing trend in heart failure, with lower rates of valvular disease and higher rates of coronary disease.

The mean SBP in the improved and remaining groups was 88.52±18.96 and 90.27±21.57 respectively, this difference was statistically significant, lower than in the EFICA study (126 ± 39 mmHg)[7], compared to Chan Soon Park et al. the mean SBP in the improved and remaining groups was also higher than our study, specifically 130.3 ± 30.5; 125.4 ± 25.7 respectively and also lower than Viorel et al.[4;5] Blood pressure higher or lower than normal is also a factor to consider in treating heart failure patients and can affect prognosis.

The mean heart rate in the improved and remaining groups was 77.62 ± 11.75 and 78.84 ± 16.69 respectively, with no statistically significant difference. The heart rate in our study is comparable to Viorel et al., with rates of 74 ± 13 and 73 ± 12 respectively; lower than Chan Soon Park et al. (97.1 ± 25.7 and 92.5 ± 23.5).[4;5]

The mean EF in our study in the improved and remaining groups was 32.23 ± 5.55 and 37.62 ± 8.73 respectively, the mean EF was significantly lower in the improved group; the rate of EF ≤ 30% was 38.1% and 27.7% respectively, higher in the improved group; the rate of 30%< EF ≤ 40% was 61.9% and 31.7% respectively, higher in the improved group. This can be explained by the improved heart failure group only including EF ≤ 40%, while the remaining group still includes mild reduced EF heart failure patients. The mean EF was lower in the study by Viorel et al. (28.7 ± 5.6 and 25.2 ± 6.2) and the study by Chan Soon Park et al. (27.3 ± 7.6 and 25.3 ± 7.1).[4;5]

Additionally, the mean NT-proBNP in our study in the improved and remaining groups was 6929.80 ± 8756.24 and 5413.12 ± 6996.60 respectively, higher than in the study by Chan Soon Park et al. (4453.0 (2336.0–9531.5) and 785.0 (2419.0–11 784.0)).[4] The mean creatinine in our study in the improved and remaining groups was 88.97 ± 31.68 and 105.13 ± 51.51 respectively, lower without statistical significance in the improved group than the remaining group; lower compared to Viorel et al. (107 ± 22 and 112 ± 26).[5]

Treatment characteristics

Looking at the drugs in the guideline-directed medical therapy for heart failure including: RAS system drugs, beta-blockers, MRAs, and SGLT2 inhibitors.

The usage rate of RAS system drugs in the improved and remaining groups was 96.4% and 86.1% respectively, significantly higher in the improved group (p<0.05). The usage rate of RAS drugs in the improved group was higher than Viorel et al. at 93%, the remaining group was lower (93%).[5] Meanwhile, these rates were much higher than author Chan Soon Park et al. (78.3% and 78.8%).[4] This rate is higher than some previous studies (80-86%).[8;9] Compared to a study conducted at Hanoi Heart Hospital, the rate of author Vu Quynh Nga et al. was 80.9% initially, after 12 months it was 86.52%, our rate was higher than theirs.[6]

The beta-blocker usage rate in our study was higher in the improved group than the remaining group, at 89.3% and 74.5% respectively, this difference was also statistically significant (p<0.05). Our rate was higher than Chan Soon Park et al. (62.9% and 57.4%); Viorel et al. (47% and 34%).[4;5] This rate when compared to other studies was also higher, for example THAI ADHERE (26.1%; after 12 months 24%), and EHFSII (43.2% after 12 months was 61.4%).[10;11] Compared to the previous study by Vu Quynh Nga conducted earlier, the proportion of patients using beta-blockers initially was 74.36%, after 12 months of treatment this rate reached 86.75%, clearly our rate was higher. The increased rates of using RAS and beta-blocker drugs compared to Vu Quynh Nga once again confirms the role of the heart failure patient management program.[6]

The MRA usage rate in our study in the improved and remaining groups was 63.1% and 64.9% respectively, with no statistically significant difference between the two groups. The rate in our study was higher than Chan Soon Park et al. at 51.1% and 59.8%.[4] This rate was also higher than the THAI ADHERE study (17.1%; after 12 months 12.5%).[11]

Compared to other studies around the world, we saw in the QUALIFY study which was a multicenter study conducted on 6,669 heart failure patients in 36 countries over 15 months to assess adherence to reduced ejection fraction heart failure treatment guidelines. The results showed up to 22% of patients were not prescribed ACEI/ARB, beta-blocker or MRA without contraindications to these drugs.[12] The 2016 study by Reyes et al. showed around 90% of heart failure patients were prescribed ACEI/ARB, however the proportion prescribed beta-blockers was only 40%.[13]

One drug usage rate not mentioned in previous domestic and foreign studies was the SGLT2 inhibitor rate. Since SGLT2 inhibitors were only recently officially included as one of the four pillars of heart failure treatment, in our 2021 study the usage rate was still low, and in 4Q 2022 the rate was still low due to stock-outs in health insurance. However, the SGLT2 inhibitor usage rate in our study was quite positive, with rates in the improved and remaining groups of 59.5% and 61.9% respectively. Although the rate was lower in the improved group than the remaining group, it was not statistically significant. In fact, SGLT2 inhibitors are not only prescribed in the reduced ejection fraction heart failure group, but also in the mildly reduced or preserved ejection fraction heart failure groups.

The usage rate of 2 drugs - RAS and beta-blockers in the improved group was lower than the remaining group, at 85.7% and 67.6% respectively, significantly higher in the improved group than the remaining group ($p<0.05$). In addition, the use of 2, 3 or 4 drugs in the improved group was also higher than the remaining group, however there was no statistically significant difference. Perhaps our sample size was not large enough.

Looking at the rate of achieving half the target dose of drug groups in our study, the rate of using RAS drugs in our study was 63% in the improved group, significantly higher than the remaining group at 49.7% ($p<0.05$); the rate of achieving half the target dose when using beta-blockers in the improved group was 34.5%, also higher than the remaining group at 31.9%, although this difference was not statistically significant. Compared to other studies, the QUALIFY study showed the proportion of patients using ACEI/ARB and beta-blockers at ≥ 50% of target dose was 55.0%, and 23% of reduced ejection fraction heart failure patients achieved target doses of ACEI/ARB and beta-blockers in the study.[12] The TSOC – HFrEF study in Taiwan followed 1509 reduced ejection fraction heart failure patients, after 1 year follow-up the proportion achieving target doses for ACEI/ARB and Beta-blockers was 25.0% and 40% respectively.[14]

When assessing the issue of rehospitalization in our study groups, we noted that rehospitalization within 1 year occurred in 9.5% of the improved group, significantly lower than the remaining group at 20.3% ($p<0.05$). In addition, the average number of rehospitalizations within 1 year in the improved group was 0.14±0.49, also significantly lower than the remaining group 0.29±0.74($p<0.04$). This may also be a contributing factor in assessing ejection fraction improvement capabilities.

Factors related to predicting improved ejection fraction heart failure

Another way to describe the relationship between sensitivity and specificity is the ROC (receiver operating characteristic) curve. By connecting points on the ROC curve, we get a continuous ROC curve. But here we have two indicators (false positive rate and sensitivity), which vary inversely. Therefore, we need a "balanced indicator" of both indicators. The best way to balance is to estimate the area under the ROC curve (also called AUC). The AUC index is very useful in comparing the accuracy of 2 or more diagnostic tests. Of course, the method with the higher AUC means that the method has higher accuracy. We used AUC to assess the ability to predict improved ejection fraction heart failure of parameters such as admission EF, LVEDVi, LVESVi. Our results were: area under the curve of admission EF, LVEDVi, LVESVi in predicting improvement were 0.687(95% CI 0.640-0.730; $p<0.001$); 0.531 (95% CI 0.462-0.599; $p=0.378$); 0.543 (95% CI 0.467-0.611; $p=0.211$), so only the admission EF index was statistically significant in predicting the ability to improve ($p<0.05$).

In addition, we used univariate and multivariate models in predicting improved heart failure, we noted admission systolic blood pressure, admission EF, surgery, rehospitalization within 1 year, ventilation during first admission were statistically significant, but when included in the multivariate model only admission EF, surgery and ventilation remained statistically significant. Thus, admission EF, surgery and ventilation are very significant indicators in predicting improved ejection fraction.

The Kaplan Meier curve is a jagged, uneven staircase, with the y-axis being the rate and the x-axis being time. On the length there are vertical marks indicating the time a subject is censored, on the height if there are horizontal marks corresponding to that timepoint when an event occurred. Among survival analysis methods, the Kaplan Meier method is the most accurate. In our study we also used Kaplan-Meier curves to predict improved ejection fraction heart failure, by using 1, 2, 3 or 4 drugs. From Figure 3.2 we can clearly see greater improvement when using 2 or 3 drugs compared to 1 drug or no drug use. When using 4 drugs the improvement rate increased but not as much as with 3 drugs, this is not because 4 drugs is not as good as 3 drugs but because our sample size is small, and our rate of 4 drug use is not high yet. In addition, the Kaplan Meier curve predicting improved heart failure after 3 months based on use of 2, 3 and 4 drugs was statistically significant (p 1 drug = 0.178; p 2 drugs = 0.01; p 3 drugs = 0.02; p 4 drugs = 0.01; the chart shows each group of 1, 2, 3, 4 drugs p = 0.049).

Previous studies have not noted the use of AUC, Cox regression or Kaplan Meier for predicting improved ejection fraction in heart failure patients.

When looking at the total number of patients with reduced ejection fraction, we noted the rate of PCI and AF ablation and ICD implantation in the improved group was 21.4%; 2.4% and 1.2% respectively, higher than the remaining group (19.6%; 1.7% and 0.8%), however the difference was not statistically significant. Looking at the surgical treatment aspect, the rates of CABG and valve replacement in the improved group were 10.7% and 15.2% respectively, significantly higher than the remaining group (5% and 8.4%) ($p<0.05$). And we also used Kaplan Meier curves to assess the ability to predict improved ejection fraction heart failure in this patient group, showing valve surgery and PCI were both statistically significant ($p<0.05$).

CONCLUSION

The rate of improved ejection fraction heart failure in the program was 17.2%. Admission systolic blood pressure, admission EF, usage rates of RAS system drugs, beta-blockers, use of 2 RAS and beta-blocker drugs, PCI, AF ablation, and CABG or valve surgery were significant in predicting improved ejection fraction heart failure in the heart failure program at Hanoi Heart Hospital.

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