The value of Hendry's Score in predicting reduced ejection fraction in chronic heart failure patients with sinus rhythm

Vu Thi Thao Hien[1]✉, Le Dieu Linh[2], Pham Manh Hung[3], Nguyen Ngoc Quang[3]

[1] Ha Dong General Hospital

[2] Hong Ngoc Hospital

[3] Hanoi Medical University

▶ **Correspondence to**

MD. Vu Thi Thao Hien

Ha Dong General Hospital

Email: vthaohien@gmail.com

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ABSTRACTS

Objectives: To evaluate the role of Hendry's score based on the electrocardiogram in predicting heart failure with reduced ejection fraction.

Methods: This is a cross-sectional study, including 91 inpatient heart failure patients at the Vietnam Heart Institute, divided into two groups: heart failure with reduced left ventricular ejection fraction (EF ≤ 40 %) and heart failure with preserved left ventricular ejection fraction (EF ≥ 50%). The collected information included the general characteristics of the disease group (age, gender, etiology, clinical symptoms), blood test NT-proBNP, creatinine, electrolytes, echocardiogram, and electrocardiogram.

Results: Forty-seven people were diagnosed with HFpEF, and 44 suffered from HFrEF. Multiple logistic regression analysis revealed certain ECG variables that were independent predictors of HFrEF, i.e., left atrial hypertrophy (LAH), QRS duration > 100 ms, right bundle branch block (RBBB), ST-T segment changes, and prolongation of the QT interval. Based on Hendry's Score, we obtained a score for HFpEF of -1 to +3. At the same time, HFrEF had a score of +4 to +6 with 81.3% sensitivity, 84% specificity, a 70.5% positive predictive value, an 87.2% negative predictive value, and an accuracy of 86%.

Conclusions: The scoring system derived from this study, including the presence or absence of LAH, QRS duration > 100 ms, RBBB, ST-T segment changes, and prolongation of the QT interval can be used to predict the type of HF with satisfactory sensitivity and specificity.

Keywords: Chronic heart failure; Electrocardiogram features; Hendry's Score; Type of heart failure.

INTRODUCTION

Heart failure is a complex clinical syndrome, with chronic left ventricular systolic dysfunction presenting the final stage in most heart diseases. Heart failure occurs in approximately 2% of the population and 10% of the population over 70 years of age [1].

According to ESC 2016, heart failure with reduced ejection fraction (HFrEF) when ejection fraction (EF) ≤ 40% and heart failure with preserved ejection fraction (HFpEF) when EF ≥ 50%, diagnostic criteria, approach The treatment, monitoring, and prognosis of these two types of heart failure are different[2]. The diagnosis of heart failure is based on clinical and laboratory features,

NT-proBNP, the gold standard of echocardiography. However, not all medical facilities have the full range of diagnostic and screening tests available. The 12-lead electrocardiogram (ECG) is a simple, practical test for many cardiovascular diseases.

A normal or minor change in the ECG is consistent with a low likelihood of left ventricle dysfunction. Conversely, major ECG changes usually accompany left ventricle systolic dysfunction [6]. The ECG is useful because it can serve as an initial investigative tool that physicians can use to determine the presence of systolic and diastolic dysfunction in patients with chronic HF, though it cannot replace echocardiography.

A scoring system is a simple method for diagnosing disease [7]. Several scoring systems based on ECG findings have been studied to estimate left ventricular function. In 2016, Purnasidha Bagaswoto Hendry's study published in Pubmed introduced a scoring system based on ECG abnormalities to predict HFrEF and HFpEF.

In Vietnam, up to now, there is no study on the Henry scale to analyse ECG abnormality in predicting heart failure according to reduced or preserved ejection fraction.

Therefore, we conducted the study to evaluate the role of Hendry's score based on the electrocardiogram in predicting heart failure with reduced ejection fraction.

METHODS

Study design

This cross-sectional study with a convenient sample method was conducted at the Vietnam Heart Institute from July 2021 to July 2022.

Study participants

Selection criteria

Patients aged 18 years or older were diagnosed with heart failure according to the European Society of Cardiology (ESC 20) criteria, which are diagnostic criteria for reduced and preserved ejection fraction heart failure.

Exclusion criteria

Congenital heart disease, valvular heart disease, pacemaker, atrial fibrillation, myocardial infarction, massive pericardial effusion, chronic obstructive pulmonary disease.

Data collection

Information includes age, sex, medical history, causes, risk factors, clinical symptoms, NYHA level of dyspnea, and paraclinical parameters such as blood biochemistry (NT-proBNP, glucose, hemoglobin), creatinine, cholesterol, electrolytes), chest x-ray, echocardiography, and surface electrocardiogram. For patients with clinical symptoms of heart failure, NT-proBNP test > 14.75 pmol/l (>125 pg/ml), echocardiography to evaluate left ventricular ejection fraction (EF) according to Simpson, if EF ≤ 40% is classified as HFrEF if EF ≥ 50% with left ventricular diastolic dysfunction is classified as HFpEF. Records of the 12-lead electrocardiogram were used to analyse the electrocardiographic characteristics. Conventions for left atrial thickening when P wave is > 0.12 s wide, biphasic P in V1, PQ long when > 0.2 s, QTc long when ≥ 0.46 s (female) and ≥ 0.45 s (male), wide QRS when ≥ 0.12s, ST-T changes when ST elevation or depression ≥ 1 mm, or flattened or negative T waves in 2 or more leads. Weak R wave when RV3 2mm and/or RV4 4mm and/or RV3< RV2, RV4 < RV3. HF was divided into HFrEF (EF≤40%) and HFpEF (EF>40%).

Data analysis

Data were entered, cleaned, analysed and processed using SPSS 16 software.

Quantitative variables are mean ± SD, and qualitative variables are percentages (%). Test the difference by T-test, Chi-squared, and Fisher test; the reliability $p < 0.05$ is considered statistically significant. There were two scoring systems based on the probability and cut-off point from the ROC curve. Next, the scoring system was validated in several samples to obtain the diagnostic value.

Research ethics

The conduct of the study does not harm the research subjects, and personal information is guaranteed to be kept private. The study was conducted with the permission of the Board of Directors of the Cardiovascular Institute - Bach Mai Hospital.

RESEARCH RESULTS

Characteristics of the participants

***Table 1**. Baseline characteristics of the participants by two groups of heart failure*

Variable		HFrEF (n=47)	HFpEF (n=44)	Total(n=91)	p
Age, year (±SD)		58.1 ± 16.2	65.0 ± 15.1	61.2 ± 15.9	0.004
Sex	Male, n	37 (79.5%)	21 (48.9%)	58(63.7%)	< 0.001
	Female, n	10 (20.5%)	23(51.1%)	33 (36.3%)	
BMI, kg/m^2		21.4 ± 3.5	22.1 ± 4.1		0.074
Time of heart failure (month), n		24.3 ± 38.3	9.2 ± 26.6	16.7 ± 33.6	0.035
History	Smoked (n,%)	70 (76.9%)	15 (34.1%)	5 (10.9%)	**0.008**
	Hypertension (n,%)	45 (49.5%)	22 (50%)	23 (48.9%)	0.92
	Diabetes (n,%)	25 (27.5%)	13 (29.5%)	12 (26.1%)	0.71

The mean age of the HFrEF group was 58 years lower than that of the HFpEF group of 65. In the HFrEF group, the incidence was higher in males (79.5%) than in females (20.5%). In the HFpEF group, the prevalence of women (51.1%) was higher than that of men (48.9%). The disease duration of the HFrEF group (24 months) was higher than that of the HFpEF group (9 months). Smoking was found in the HFrEF group at a higher rate than in the HFpEF group. The difference was statistically significant with $p < 0.05$. There was no significant difference in BMI, hypertension, and diabetes in the two groups.

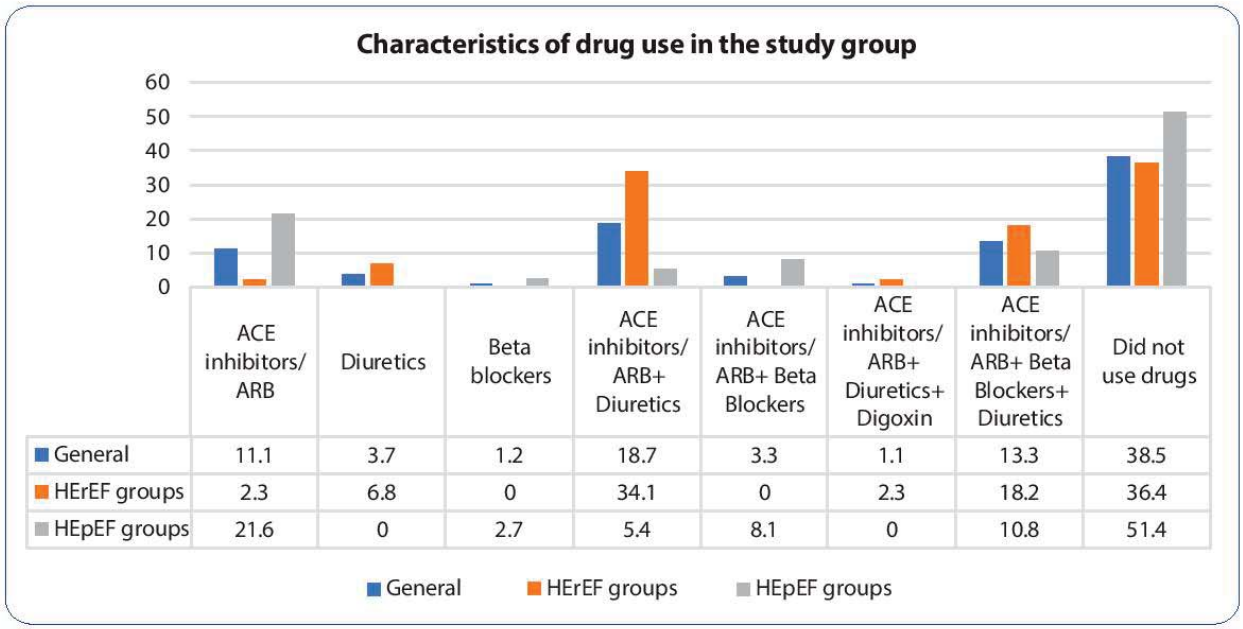

***Figure 1**. Characteristics of drug use in the study population*

The group that did not use drugs accounted for a high proportion of the study group, with the rate in the general group being 38.5% and mainly from the HEpEF group (51.4%). The two groups with the highest rates were those using ACE inhibitors + diuretics + beta blockers and those using ACE inhibitors + diuretics. The HErEF group was mainly used for ACE inhibitors rather than beta blockers.

***Table 2**. Clinical characteristics of the participants*

Decreased	All patients (n=91)	HErEF group (n=44)	HEpEF group (n = 47)	p
Dyspnea				
No difficulty in breathing	4.7%	0%	9.5%	
NYHA I	9.3%	9.1%	9.5%	
NYHA II	44.2%	40.9%	47.6%	0.207
NYHA III	33.7%	40.9%	26.2%	
NYHA IV	8.1%	9.1%	7.1%	
Edema	31.4%	36.4%	26.2%	0.31
Pulmonary rales	43%	54.5%	31%	**0.027**
Enlarged heart	39.5%	63.6%	14.3%	**0.001**
Jugular vein distention	15.1%	27.3%	2.4%	**0.001**
Hepatomegaly	15.1%	25%	4.8%	**0.009**
Blood pressure				
Normal	73.3%	68.2%	78.6%	0.347
Increased	20.9%	22.7%	19.0%	
Decreased	5.8%	9.1%	2.4%	

Regarding dyspnea according to NYHA classification, the overall study group had the highest rate of NYHA class II and III (44.2% and 33.7%, respectively). The group with HErEF mainly expressed at NYHA II and III levels (40.9% and 40.9%), while the group with HEpEF showed much at NYHA II and I levels (47.6% and 9.5%, respectively)). Besides that, 9.5% of patients did not show dyspnea, and the difference between the two groups was not statistically significant, with $p > 0.05$.

Regarding other symptoms, the most common symptom was the presence of rales in the lungs and enlarged heart (accounting for about 40% in the general group). When we compared the two groups with reduced EF and preserved EF, we found the rate of these two symptoms in the group with reduced EF was statistically significant, $p<0.05$.

Echocardiographic characteristics of the participants

***Table 3**. Electrocardiographic characteristics of the participants*

Characteristics	All patients (n=91)	HErEF group (n=44)	HEpEF group (n = 47)	p
EF	46.6 ± 18.1	29.4 ± 6.4	62.8 ± 7.1	0.001
LAD	38.1 ± 7.8	42.3 ± 7.2	34.2 ± 6.2	0.001
Dd	53.7 ± 12.4	63.1 ± 9.8	44.8 ± 6.9	0.001
Ds	40.9 ± 14.5	53.5 ± 0.7	29.2 ± 5.8	0.001
IVSd	12.2 ± 3.5	10.7 ± 2.4	13.6 ± 3.8	0.014
IVSs	9.0 ± 2.6	8.3 ± 2.2	9.7 ± 2.8	0.013
LVMI	131.7 ± 53.0	162.6 ± 47.6	101.5 ± 39.0	0.001
Movement disorders	55.6%	93.2%	19.6%	0.001

The mean ejection fraction value of the study group was 46.6%. The group with HErEF had an average ejection fraction of 29.4%, statistically significantly lower than the HEpEF group with 62.8%.

The mean end-systolic and diastolic left ventricular diameters were 53.7% and 40.9%, respectively. In which the group with HErEF had more enormous mean Dd and Ds than the group with preserved EF, the difference was statistically significant with $p < 0.05$.

The rate of regional movement disorders of the group with HErEF was much higher than that of the group with HEpEF (93.2% versus 19.6%), and the difference was statistically significant($p<0.05$).

***Table 4**. Electrocardiogram characteristics of the participants*

Characteristics	General Group (n=91)	HErEF group (n=44)	HEpEF group (n = 47)	p
Thick left atrium	23 (25.3%)	18 (40.9%)	5 (10.6%)	0.001
Thick left ventricle	40 (44%)	35 (79.5%)	5 (10.6%)	0.001
Weak R wave at V3	22 (24.2%)	18 (40.9%)	4 (8.5%)	0.001
LBBB	13 (14.3%)	13 (29.5%)	0 (0%)	0.001
RBBB	9 (9.9%)	6 (13.6%)	3 (6.4%)	0.247
Pathological Q waves	16 (17.6%)	23 (52.3%)	4 (8.5%)	0.001
Long QT	16 (17.6%)	12 (27.3%)	4 (8.5%)	0.019
Change the ST segment	45 (49.5%)	32 (72.7%)	13 (27.7%)	0.001

The two most common signs in the general study group were left ventricular thickening and ST segment changes (44% and 49.5%), respectively. The comparison between the group with HErEF and the group with HEpEF showed features of left atrial thickening, left ventricular thickening, weak R wave in V3, Left bundle branch block, pathological Q wave, prolonged QT and regular ST segment changes.

It was found mainly in the group with reduced EF; the difference was statistically significant with $p < 0.05$. Only the characteristic feature of Right bundle branch block was no statistically significant difference between the two groups.

The Hendry's score

***Table 5**. Henry's score characteristics of the participants*

Characteristics	All patients (n=91)	HErEF group (n=44)	HEpEF group (n = 47)	p
0 points	37 (40.7%)	5 (11.4%)	32 (68.1%)	**0.001**
1 point	17 (18.7%)	8 (18.2%)	9 (19.1%)	
2 points	7 (7.7%)	5 (11.4%)	2 (4.3%)	
3 points	19 (20.9%)	17 (38.6%)	2 (4.3%)	
4 points	3 (3.3%)	2 (4.5%)	1 (2.1%)	
5 points	7 (7.7%)	6 (13.6%)	1 (2.1%)	
6 points	1 (1.1%)	1 (2.3%)	0 (0%)	

Henry's score for the participants most encountered was 0 points, which mainly in the group with preserved EF, and this difference was statistically significant, $p < 0.05$.

The HErEF group also had Henry's score mainly from 3 points or more, while the EF group mainly had Henry's score of less than 3 points. This difference was also statistically significant, $p < 0.05$.

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***Table 6**. Cut-off point and corresponding specificity sensitivity value*

Threshold cut point	Sensitivity	Specificity
-1	100.0%	0.0%
0.5	88.6%	68.1%
1.5	70.5%	87.2%
2.5	59.1%	91.5%
3.5	20.5%	95.7%
4.5	15.9%	97.9%
5.5	2.3%	100.0%
7	0.0%	100.0%

When the cut-off threshold is chosen (1.5), it shows that Hendry's score has a sensitivity of 70.5% and a specificity of 87.2%. The curve area of Hendry's score is the largest AUC (0.845) in the project for diagnosing heart failure with reduced ejection fraction.

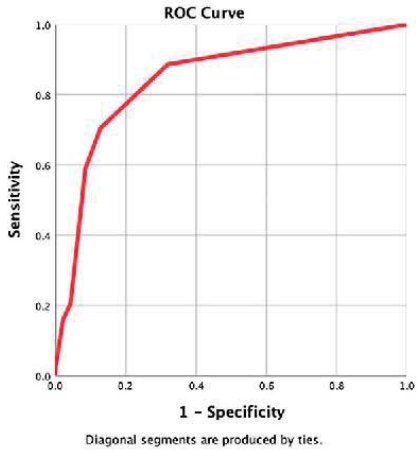

***Figure 2**. ROC curve of Hendry's score in predicting heart failure with reduced ejection fraction (The AUC = 0.845)*

DISCUSSION

Hendry's score was first published in 2016, showing the value of ECG indicators to help determine whether heart failure has reduced or preserved ejection fraction.[6] In our study, the Hendry scale scored 0 - 6 points. The 0-point level accounted for the most (40.7%), of which the group with HEpEF accounted for 32/37 cases. The level of 1 point shows that the ratio of the two groups is quite similar in that the HEpEF group is still slightly higher in 9/17 cases compared to 8/17 patients in the HErEF group. From the level of 2 points or more, it is mainly the group with reduced EF, in which the level of 3 points is seen, mainly, the group with HErEF has Hendry's score ≥ 3 points with 17/19 cases, and the highest group, Hendry 6 points. There was 1 case of HErEF and no case of HEpEF with an electrocardiogram reaching 6 points, and these differences were statistically significant with $p < 0.05$ (Table 3.9). Hendry's study also showed that the most significant value between the group of HErEF and HEpEF was at the threshold of 3 points; < 3 points is likely HFpEF, and > 3 points is likely HFrEF.In our study, when the cut-off value of the Hendry scale was chosen as 1.5, it showed the value of the Hendry scale in determining the type of heart failure whose ejection fraction is preserved or decreased with the area below curve is 0.858, sensitivity and specificity values are 81.3% and 84%. When compared with the use of this scale by Hendry, the sensitivity and specificity values are 76% and 96%, respectively. 6 Thus, our diagnostic value is lower than that of Hendry's author, and in Hendry's study, it also shows the value of diagnostic ability of corresponding values of Hendry points, in which diagnostic ability predicting heart failure EF reduction was 98.5%. In our study, there was only 1 case with Hendry's score of 6, and this case was confirmed as HErEF on echocardiography, corresponding to the determination value of Hendry's score of 6 points, determining HErEF is 100%.

CONCLUSION

Our results suggest that a scoring system

based on ECG findings that include the presence or absence of LAH, a wide QRS duration, RBBB, ST-T segment changes, and a prolonged extended QTc interval can be used to predict the type of HF (HFpEF and HFrEF) in patients with chronic HF with a good performance. A score of -1 to +3 suggests the possibility of HFpEF, while a score of +4 to +6 suggests the possibility of HFrEF.

REFERENCES

1. Roger VL. Epidemiology of heart failure. Circ Res. 2013;113(6):646-659. doi:10.1161/CIRCRESAHA.113.300268
2. Ponikowski P, Voors AA, Anker SD, et al. 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: The Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC)Developed with the special contribution of the Heart Failure Association (HFA) of the ESC. Eur Heart J. 2016;37(27):2129-2200. doi:10.1093/eurheartj/ehw128
3. Hendry PB, Krisdinarti L, Erika M. Scoring System Based on Electrocardiogram Features to Predict the Type of Heart Failure in Patients With Chronic Heart Failure. Cardiol Res. 2016;7(3):110-116. doi:10.14740/cr473w
4. Bhatia RS, Tu JV, Lee DS, et al. Outcome of heart failure with preserved ejection fraction in a population-based study. N Engl J Med. 2006;355(3):260-269. doi:10.1056/NEJMoa051530
5. Owan TE, Hodge DO, Herges RM, et al. Trends in prevalence and outcome of heart failure with preserved ejection fraction. N Engl J Med. 2006;355(3):251-259. doi:10.1056/NEJMoa052256
6. Tsutsui H, Tsuchihashi-Makaya M, Kinugawa S. Clinical characteristics and outcomes of heart failure with preserved ejection fraction: lessons from epidemiological studies. J Cardiol. 2010;55(1):13-22. doi:10.1016/j.jjcc.2009.09.003
7. Paulus WJ, Tschöpe C. A novel paradigm for heart failure with preserved ejection fraction: comorbidities drive myocardial dysfunction and remodeling through coronary microvascular endothelial inflammation. J Am Coll Cardiol. 2013;62(4):263-271. doi:10.1016/j.jacc.2013.02.092
8. van Veldhuisen DJ, Linssen GC, Jaarsma T, et al. B-type natriuretic peptide and prognosis in heart failure patients with preserved and reduced ejection fraction. J Am Coll Cardiol. 2013;61(14):1498-1506. doi:10.1016/j.jacc.2012.12.044
9. Karaye KM, Sani MU. Electrocardiographic abnormalities in patients with heart failure. Cardiovasc J Afr. 2008;19(1):22-25.
10. McMurray JJ, Adamopoulos S, Anker SD, et al. ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2012: The Task Force for the Diagnosis and Treatment of Acute and Chronic Heart Failure 2012 of the European Society of Cardiology. Developed in collaboration with the Heart Failure Association (HFA) of the ESC. Eur Heart J. 2012;33(14):1787-1847. doi:10.1093/eurheartj/ehs104