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Original article

# Adherence to the European Guidelines on the Management of Heart Failure in Ambulatory Care

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## Abstract:

**Background:** Chronic Heart Failure (CHF) diagnosis requires symptoms/signs of HF and objective evidence of cardiac dysfunction. Effective management, as per European Society of Cardiology (ESC) guidelines, is critical for reducing mortality and improving quality of life in HF patients. This study aims to assess adherence to ESC guidelines on pharmacological and device-based treatments of HF, including angiotensin receptor neprilysin inhibitor (ARNI) and sodium-glucose Co-transporter 2 (SGLT2) inhibitors, in a contemporary cohort of Egyptian HF patients. **Methods:** This cross-sectional, multi-center, observational study was carried out on 500 HF patients categorized according to ejection fraction into 3 groups: HFrEF, HFmrEF, and HFpEF. Data were collected via structured interviews, observations, and medical file reviews. **Results:** Of 500 patients, 310 had HFrEF, 115 had HFmrEF, and 75 had HFpEF. HFpEF patients had a higher mean BMI (27.6 kg/m²). HF histories ($P < 0.001$) varied, with HFrEF at 83.9%, HFmrEF at 67.8%, and HFpEF at 89.3%. Hospitalization histories ($P < 0.001$) were 39.7% in HFrEF, 13.9% in HFmrEF, and 13.3% in HFpEF. Medication use varied significantly; ACE inhibitors ($P = 0.002$), ARBs ($P < 0.001$), and ARNI ($P < 0.001$) were more common in HFrEF. Significant differences were observed in abnormal ECG findings ($P < 0.001$) and echocardiographic parameters. Device-based therapy utilization was minimal across all groups. **Conclusion:** Adherence to European HF guidelines is limited in Egyptian patients, with low use of ARNI and SGLT2 inhibitors. High costs, lack of awareness, and comorbidities are major barriers.

**Keywords:** Heart failure; European guidelines; ARNI; SGLT2 inhibitors; ACE inhibitors.

## Introduction

Diagnosing Chronic Heart Failure (CHF) requires the presence of HF symptoms and signs, combined with objective evidence of cardiac dysfunction. Common symptoms include respiratory distress, profound fatigue, and ankle edema. However, these symptoms alone are insufficient for a definitive diagnosis. Individuals with a history of myocardial infarction (MI), high blood pressure, coronary artery disease (CAD), diabetes mellitus, alcohol abuse, chronic kidney disease (CKD), exposure to cardiotoxic chemotherapy, or a family history of cardiomyopathy (CMP) or sudden cardiac death are at higher risk of developing CHF [(1)].

In 2018, approximately 6.2 million people in the United States were affected by HF, with 379,800 death certificates (13.4%) citing HF as a contributing factor [(2)]. Although the age-adjusted incidence of HF is declining in developed countries due to advancements in cardiovascular disease management, the overall incidence is rising due to the aging population [(3)]. In Europe, the incidence of HF is about 3 cases per 1,000 person-years across all age groups, increasing to 5 cases per 1,000 person-years in adults [(4)].

Pharmacotherapy is the primary and most important treatment for HF with reduced ejection fraction (HFrEF). The main objectives are to decrease mortality rates, prevent recurrent hospitalizations due to worsening HF, and enhance clinical status, physical capacity, and overall quality of life [(5)].

The principal pharmaceutical therapies include angiotensin-converting enzyme inhibitors (ACE-I) or angiotensin receptor-neprilysin inhibitors (ARNI), beta-blockers, and mineralocorticoid receptor antagonists (MRA). These medications have proven effective in improving survival rates, reducing HF -related hospitalizations, and relieving symptoms [(6)].

The European Society of Cardiology (ESC) guidelines recommend replacing ACE inhibitors (ACE-I) with angiotensin receptor-neprilysin inhibitors (ARNI) in symptomatic patients who are already on ACE inhibitors, beta-blockers, and mineralocorticoid receptor antagonists (MRAs). ARNI may also be considered a first-line therapeutic option [(4)].

Furthermore, the use of sodium-glucose co-transporter 2 (SGLT2) inhibitors, specifically dapagliflozin and empagliflozin, has shown efficacy in reducing the risk of cardiovascular mortality and HF exacerbations when used alongside ACE-I/ARNI, beta-blockers, and MRAs, regardless of the patient's diabetic status [(7)].

This study aims to assess adherence to European guideline recommendations on pharmaceutical and device-based treatments, including ARNI and SGLT2 inhibitors, among a cohort of Egyptian HF patients in real-world clinical settings.

## Patients and methods:

This study was carried out as a cross-sectional, multi-center, observational prevalence survey at the Benha Health Insurance Outpatient Cardiovascular Clinic and Benha University Hospitals Outpatient Cardiovascular Clinic. The study lasted for one year, commencing in February 2023 and concluding in January 2024. The study comprised a cohort of 500 Egyptian individuals diagnosed with HF. The individuals included in this study were either individuals who visited the clinics of the specified centers as outpatients or individuals who had previously been admitted for acute, pre-existing, or new-onset HF.

Every patient or first-degree relative was obligated to furnish an informed written consent. Every patient received a thorough explanation about the purpose of the study and was given a distinct code number. The study was conducted with the endorsement of the Research Ethics Committee of the Faculty of Medicine at Benha University (Approval Number: Ms 6-5-2023).

The inclusion criteria included all outpatients with CHF at the collaborating centers, as well as patients who had previously been admitted to the partnering centers and had either newly developed HF [(1)] or acute decompensated HF[(8)]. However, exclusion criteria were patients aged < 18 years.

**Grouping:** Patients were classified into three groups according to EF, group 1: Patients with HFrEF, group 2: Patients with HFmrEF and group 3: Patients with HFpEF.

Each patient attended a meeting where the researcher explained the study's objectives and procedures and obtained informed consent before reviewing medical files. The researcher explained the questionnaire, which was completed during the meeting. Data was collected using a structured interview questionnaire, along with observations and reviewing patients' files, consisting of the following:

**Socio-demographics**: Socio-demographic data were collected, including age, sex, BMI, marital status, educational level, and employment status. Patients were classified by BMI according to WHO standards [(9)].

**Possible causes & risk factors of HF:** Comorbidities (e.g., Diabetes mellitus, anemia, lung disease, renal disease, and hypertension), Myocardial infarction, familial, congenital diseases, and smoking [(10)].

**Full clinical examination:** It was conducted, focusing on pulse, blood pressure, and auscultation for pulmonary congestion and heart murmurs. Patient files were reviewed for laboratory tests (complete blood count, serum creatinine, sodium, troponin, potassium), baseline ECG for arrhythmias or wall motion abnormalities, and transthoracic echocardiography using a vivid machine with a 3S-RS probe according to American Society of Cardiology guidelines [(11)].

**Two-Dimensional echocardiography:** The American Society of Echocardiography recommended using the modified Simpson method with Two-Dimensional echocardiography to evaluate EF and RWMA (regional wall motion abnormalities). This method involves outlining the inner boundary of the LV in images taken from the apical four-chamber and two-chamber views at the end of the contraction and relaxation phases of the heart. The LV cavity is further divided into disks in order to calculate volumes based on these delineations [(11)].

**Color flow mapping, M mode, pulsed wave, and continuous wave Doppler**: To calculate LV end-systolic diameter, LV end-diastolic diameter, valve lesion, and its grade, left atrial diameter, and left ventricular hypertrophy [(11)].

**Management strategy**: Medical treatment included ACE inhibitors, ARNI, beta-blockers, aldosterone antagonists, SGLT2 inhibitors, diuretics, angiotensin receptor blockers, and inotropic agents while interventional procedures included CRT and ICD implantation, PCI, and CABG.

**Statistical analysis**

SPSS version 28 (IBM, Armonk, New York, United States) was utilized for data administration and statistical analysis. The normality of the quantitative data was evaluated using the Kolmogorov-Smirnov test and visual techniques. The data were summarized using either means and standard deviations or medians and ranges for quantitative data, and numbers and percentages for categorical data. The quantitative comparisons were conducted using either one-way ANOVA or Kruskal-Wallis tests. For significant effects, Bonferroni-adjusted post-hoc analysis was applied. The comparison of categorical data was conducted using either the Chi-square test or Fisher's exact test. Statistical tests with p-values less than 0.05 on both sides were deemed significant.

## Results:

The study included 500 heart failure patients divided into three groups: 310 with HFrEF, 115 with HFmrEF, and 75 with HFpEF. A notable gender disparity was observed, with more males in HFrEF

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and HFmrEF (84.8% and 83.5%) and more females in HFpEF (68%). HFpEF patients had a higher mean BMI (27.6 kg/m²) than HFrEF and HFmrEF (25.1 kg/m²). HF histories ($P < 0.001$) varied, with 83.9% in HFrEF, 67.8% in HFmrEF, and 89.3% in HFpEF. Hospitalization histories ($P < 0.001$) were 39.7% in HFrEF, 13.9% in HFmrEF, and 13.3% in HFpEF. HFpEF patients had a higher mean heart rate (80 bpm) than HFrEF and HFmrEF (71 bpm). SBP and DBP were higher in HFpEF (135/83 mmHg). Atrial fibrillation ($P < 0.001$) was lowest in HFrEF (4.8%) and highest in HFpEF (42.7%). Smoking history ($P < 0.001$) was highest in HFrEF (43.5%) and lowest in HFpEF (14.7%). Sleep apnea history ($P < 0.001$) was highest in HFpEF (28%). Comorbidities like Diabetes Mellitus, prior MI/ACS, and PCI varied significantly, with HFpEF having lower prevalence. Other parameters showed no significant differences.

Baseline hemoglobin levels were considerably higher in HFrEF compared to HFmrEF and HFpEF (13 ± 1.2 vs. 12.8 ± 1.3 vs. 12.3 ± 1.2 gm%, $P < 0.001$). Baseline sodium levels were lower in HFmrEF (138 ± 2) compared to HFrEF and HFpEF (both 139 ± 2, $P = 0.017$). High-sensitivity troponin was more prevalent in HFmrEF (67.7%) than in HFrEF (80.6%) and absent in HFpEF (0%, $P = 0.004$). Baseline creatinine ($P = 0.995$), eGFR ($P = 0.494$), potassium ($P = 0.421$), and random blood glucose levels ($P = 0.031$) showed no significant differences among the groups. Table 1

Medication use varied significantly among the groups. ACE inhibitor use ($P = 0.002$) showed higher captopril use in HFrEF and HFmrEF (10.3% and 13.9%) compared to HFpEF (2.7%) and higher ramipril use in HFrEF (52.6%) compared to HFmrEF (47%) and HFpEF (37.3%). ARB use ($P < 0.001$) was higher for candesartan and olmesartan in HFrEF, and valsartan in HFmrEF. Angiotensin receptor neprilysin inhibitor use was higher in HFrEF (33.2%) than in HFmrEF (7%) and HFpEF (2.7%) ($P < 0.001$). Beta-blocker use ($P = 0.004$) was higher in HFrEF (68.1%) than HFmrEF (63.5%) and HFpEF (45.3%). MRA use ($P < 0.001$) and SGLT2 inhibitor use ($P < 0.001$) were also higher in HFrEF. Other medications, including oral diuretics, antiplatelets, oral anticoagulants, digitalis, and oral anti-diabetic drugs, showed significant differences. No significant differences were found for ivabradine, amiodarone, insulin, and COPD treatment.

Abnormal ECG findings were more prevalent in HFrEF (75.5%) and HFmrEF (83.5%) than in HFpEF (41.3%; $p < 0.001$). Chest X-rays were less frequent in HFpEF (1.3%) compared to HFrEF (14.8%) and HFmrEF (7%; $p = 0.001$), with most abnormalities in HFrEF (97.8%). Echocardiographic findings showed higher left ventricular hypertrophy (LVH) in HFpEF (33.3%), and larger left atrial (LA) diameter and left ventricular end-diastolic diameter (LVEDD) compared to HFrEF and HFmrEF ($p < 0.001$). Moderate-to-severe mitral regurgitation (MR) and tricuspid regurgitation (TR) were more common in HFrEF ($p < 0.001$ and 0.027), while HFpEF had more moderate-to-severe aortic stenosis (AS; $p < 0.001$). Coronary angiography and revascularization, mainly via PCI, were more frequent in HFrEF and HFmrEF, with higher rates of abnormalities ($p < 0.001$). No significant differences were observed in other parameters. Table 2

The comparative analysis revealed significant differences in non-pharmacological and device-based therapies among HFrEF, HFmrEF, and HFpEF patients. Pacemaker implantation was rare, with only one case in the HFpEF group (1.3%). CRT and ICD utilization were also minimal across all groups. Table 3

**Table 1:** Baseline laboratory characteristics of the studied patients according to heart failure status.

| | HFrEF (n = 310) | HFmrEF (n = 115) | HFpEF (n = 75) | | P-value |
|---|---|---|---|---|---|
| **Baseline Hemoglobin (gm%)** | 13 ±1.2 [3] | 12.8 ±1.3 [3] | 12.3 ±1.2 [1,2] | 12.9 ±1.3 | **<0.001*** |
| **Baseline creatinine (mg/dl)** | 0.9 (0.5 - 10) | 0.9 (0.5 - 2) | 0.9 (0.5 - 1.2) | 0.9 (0.5 - 10) | 0.995 |
| **Baseline eGFR (ml/min)** | 88 ±10 | 89 ±7 | 88 ±4 | 88 ±8 | 0.494 |
| **Baseline sodium (mEq/L)** | 139 ±2 [2] | 138 ±2 [1,3] | 139 ±1 [2] | 139 ±2 | **0.017*** |
| **Baseline potassium (mEq/L)** | 4.1 ±0.2 | 4.1 ±0.2 | 4.1 ±0.2 | 4.1 ±0.2 | 0.421 |
| **Random blood glucose (mg/d)** | 130 (90 - 330) [2] | 120 (90 - 300) [1] | 110 (99 - 310) | 120 (90 - 330) | **0.031*** |
| **Positive hsTroponin** | 67 (67.7) | 25 (80.6) | 0 (0) | 92 (68.7) | **0.004*** |

Data were presented as Mean ±SD, Median (range) or number (percentage), *Significant P-value; 1: Significantly different from HFrEF group; 2: Significantly different from HFmrEF group; 3: Significantly different from HFpEF group; HFrEF: Heart Failure with Reduced Ejection Fraction; HFmrEF: Heart Failure with Mid-range Ejection Fraction; HFpEF: Heart Failure with Preserved Ejection Fraction; SD: Standard deviation; gm%: grams per deciliter; mg/dl: milligrams per deciliter; eGFR: estimated Glomerular Filtration Rate; mEq/L: milliequivalents per liter; hsTroponin: high-sensitivity Troponin.

**Table 2:** Radiological workup according to heart failure status

| | | HFrEF (n = 310) | HFmrEF (n = 115) | HFpEF (n = 75) | P-value |
|---|---|---|---|---|---|
| **Abnormal ECG** | n (%) | 234 (75.5) | 96 (83.5) | 31 (41.3) | **<0.001*** |
| **If abnormal, "major" ECG finding is?** | | | | | |
| AF | n (%) | 14 (6) | 9 (9.4) | 24 (77.4) | NA |
| LBBB | n (%) | 17 (7.3) | 3 (3.1) | 0 (0) | |
| LVH | n (%) | 0 (0) | 0 (0) | 2 (6.5) | |
| Other abnormality | n (%) | 140 (59.8) | 65 (67.7) | 3 (9.7) | |
| Paced rhythm | n (%) | 1 (0.4) | 0 (0) | 0 (0) | |
| Pathological Q waves | n (%) | 59 (25.2) | 17 (17.7) | 0 (0) | |
| RBBB | n (%) | 3 (1.3) | 2 (2.1) | 2 (6.5) | |
| **CXR performed** | n (%) | 46 (14.8) | 8 (7) | 1 (1.3) | **0.001*** |
| **Abnormal Chest X-ray** | n (%) | 45 (97.8) | 4 (50) | 0 (0) | **<0.001*** |
| **Major" abnormality was** | | | | | |
| Alveolar edema | n (%) | 6 (13.3) | 0 (0) | 0 (0) | 1 |
| Cardiomegaly | n (%) | 39 (86.7) | 4 (100) | 0 (0) | |
| **LVH in echo** | n (%) | 1 (0.3) | 0 (0) | 25 (33.3) | **<0.001*** |
| **LA diameter in echo (in cm)** | Mean ±SD | 4 ±0.4 [2] | 3.8 ±0.4 [1,3] | 4.2 ±0.6 [2] | **<0.001*** |
| **LVEDD in echo (in cm)** | Mean ±SD | 6.2 ±0.5 [2,3] | 5.7 ±0.2 [1,3] | 5.1 ±0.4 [1,2] | **<0.001*** |
| **Moderate-to-severe MR in echo** | n (%) | 156 (50.3) | 29 (25.2) | 31 (41.3) | **<0.001*** |
| **More than moderate MS in echo** | n (%) | 4 (1.3) | 6 (5.2) | 13 (17.3) | **<0.001*** |
| **Moderate-to-severe AR in echo** | n (%) | 10 (3.2) | 6 (5.2) | 10 (13.3) | **0.002*** |
| **Moderate-to-severe AS in echo** | n (%) | 0 (0) | 4 (3.5) | 9 (12) | **<0.001*** |
| **Moderate-to-severe TR in echo** | n (%) | 27 (8.7) | 7 (6.1) | 13 (17.3) | **0.027*** |
| **ePASP in echo (mmHg)** | Mean ±SD | 34 ±7 [3] | 33 ±7 [3] | 39 ±10 [1,2] | **<0.001*** |
| **Coronary angiography done** | n (%) | 245 (79) | 107 (93) | 72 (96) | **<0.001*** |
| **Abnormal coronary angiography,** | n (%) | 212 (86.5) | 99 (92.5) | 12 (16.7) | **<0.001*** |
| **If coronary angiography was abnormal, was it** | | | | | |
| Left main disease | n (%) | 1 (0.5) | 0 (0) | 0 (0) | **<0.001*** |
| Single vessel disease | n (%) | 18 (8.5) | 15 (15.2) | 7 (58.3) | |
| Three vessel disease | n (%) | 80 (37.7) | 33 (33.3) | 4 (33.3) | |
| Two vessel disease | n (%) | 113 (53.3) | 51 (51.5) | 1 (8.3) | |
| **If coronary angiography was abnormal, was revascularization attempted** | | | | | |
| Yes, by GABG | n (%) | 15 (7.1) | 3 (3) | 0 (0) | **0.01*** |
| Yes, by PCI | n (%) | 139 (65.6) | 70 (70.7) | 3 (25) | |
| No | n (%) | 58 (27.4) | 26 (26.3) | 9 (75) | |

*Significant P-value; 1: Significantly different from HFrEF group; 2: Significantly different from HFmrEF group; 3: Significantly different from HFpEF group; GABG: Coronary Artery Bypass Grafting; PCI: Percutaneous Coronary Intervention; ECG: Electrocardiogram; CXR: Chest X-ray; LVH: Left Ventricular Hypertrophy; LA: Left Atrium; LVEDD: Left Ventricular End Diastolic Dimension; MR: Mitral Regurgitation; MS: Mitral Stenosis; AR: Aortic Regurgitation; AS: Aortic Stenosis; TR: Tricuspid Regurgitation; ePASP: Estimated Pulmonary Arterial Systolic Pressure.

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**Table 3:** Non-pharmacological and device-based therapies according to heart failure status.

| | HFrEF (n = 310) | HFmrEF (n = 115) | HFpEF (n = 75) | | P-value |
|---|---|---|---|---|---|
| **Pacemaker implantation done** | | | | | |
| Yes | 0 (0) | 0 (0) | 1 (1.3) | 1 (0.2) | 0.150 |
| No | 310 (100) | 115 (100) | 74 (98.7) | 499 (99.8) | |
| **CRT (D/P) done** | | | | | |
| Yes | 1 (0.3) | 0 (0) | 0 (0) | 1 (0.2) | 1 |
| No | 309 (99.7) | 115 (100) | 75 (100) | 499 (99.8) | |
| **ICD done** | | | | | |
| Yes | 0 (0) | 0 (0) | 0 (0) | 0 (0) | - |
| No | 310 (100) | 115 (100) | 75 (100) | 500 (100) | |
| **Patient health education given** | | | | | |
| Yes | 310 (100) | 115 (100) | 74 (98.7) | 499 (99.8) | 0.150 |
| No | 0 (0) | 0 (0) | 1 (1.3) | 1 (0.2) | |
| **Patient scheduled for rehabilitation** | | | | | |
| Yes | 34 (11) | 8 (7) | 8 (10.7) | 50 (10.0) | 0.462 |
| No | 276 (89) | 107 (93.0) | 67 (89.3) | 450 (90.0) | |

Data were presented as number (Percentage), CRT: Cardiac Resynchronization Therapy; D: Defibrillator; P: Pacemaker; ICD: Implantable Cardioverter Defibrillator.

## Discussion:

Dyspnea, fatigue, and ankle edema are common signs of HF. It is common in persons with MI, hypertension, CAD, diabetes, CKD, and cardiomyopathy. Effective treatment includes ACE inhibitors, ARNI, beta-blockers, MRAs, and SGLT2 inhibitors, according to ESC guidelines [12]. Our goal is to analyze Egyptian patients' compliance with these HF recommendations to identify clinical practice gaps that could improve patient outcomes.

Our study included 500 HF patients, divided into three groups: 310 with reduced ejection fraction (HFrEF), 115 with mid-range (HFmrEF), and 75 with preserved (HFpEF).

Males were more common in the HFrEF and HFmrEF groups, while females were more prevalent in the HFpEF group. HFpEF patients had a higher average BMI compared to those in the HFrEF and HFmrEF groups. The HFrEF group had the highest incidence of past HF and hospitalizations, followed by the HFmrEF group, with the HFpEF group having the lowest incidence. Additionally, HFpEF patients had higher average heart rates and blood pressure readings compared to the other groups.

Comorbidities and lifestyle factors varied significantly among the groups. The HFpEF group had the highest prevalence of atrial fibrillation (42.7%) and sleep apnea (28%), while the HFrEF group had the highest percentage of smokers (43.5%). Diabetes mellitus, prior myocardial infarction/acute coronary syndrome (MI/ACS), and PCI were less common in HFpEF patients compared to HFrEF and HFmrEF patients. Other parameters did not show significant differences according to HF status.

Our findings align with those of a study reported similar distributions of HF subtypes and gender differences. Their study also highlighted higher BMIs in HFpEF and HFmrEF patients compared to HFrEF patients and significant differences in cardiovascular risk factors and comorbidities [13]. It also noted HFrEF as the most prevalent type, with higher incidences of hypertension and ACS in patients with reduced EF [14]. Also, a study found that HFpEF patients were older, more frequently female, and had a higher burden of comorbidities, including atrial fibrillation and hypertension, compared to HFrEF patients [15].

Baseline hemoglobin levels were significantly higher in patients with HFrEF compared to those with HFmrEF and

HFpEF. This may be explained by the different pathophysiological mechanisms underlying these HF subtypes. Patients with HFrEF often experience chronic volume overload and reduced renal perfusion, leading to the activation of erythropoietin and subsequent erythropoiesis, resulting in higher hemoglobin levels [(16)]. Conversely, patients with HFpEF, often characterized by comorbid conditions such as hypertension and diabetes, may have lower hemoglobin levels due to chronic inflammation and renal dysfunction, which impair erythropoiesis [(17)].

The use of medications varied significantly among HF groups, reflecting differences in disease pathology and guideline recommendations. Studies have shown that the utilization of specific HF medications is tailored to the subtype of HF, considering their unique pathophysiological mechanisms and patient profiles [(18-20)].

In our study, ACE inhibitors were more frequently used in patients with HFrEF and HFmrEF compared to those with HFpEF. Specifically, Captopril and Ramipril usage was higher in HFrEF and HFmrEF than in HFpEF. These findings are consistent with the European Society of Cardiology (ESC) guidelines, which strongly recommend ACEIs for HFrEF due to their proven mortality and morbidity benefits [(21)]. A study demonstrated the efficacy of ACEIs in improving outcomes for patients with reduced ejection fraction [(22)].

ARBs showed a higher usage of candesartan and olmesartan in HFrEF, with valsartan being more commonly used in HFmrEF. This variation can be attributed to the intolerance of some patients to ACEIs, necessitating the use of ARBs as an alternative [(23)]. The preferential use of different ARBs in specific HF subtypes may also be influenced by physician familiarity and regional prescribing practices.

The use of ARNI was more common in HFrEF (33.2%) compared to HFmrEF (7%) and HFpEF (2.7%). This significant difference is likely due to the strong evidence supporting the benefits of ARNI in reducing cardiovascular mortality and HF hospitalization in HFrEF patients, as demonstrated in the PARADIGM-HF trial [(23)]. The lower adoption in HFmrEF and HFpEF reflects the emerging and less robust evidence base for these subtypes.

Beta-blockers, particularly bisoprolol, were more frequently used in HFrEF (68.1%) compared to HFmrEF (63.5%) and HFpEF (45.3%). This is aligned with current guidelines, which recommend beta-blockers for all patients with HFrEF to improve survival and reduce hospitalizations [(21)].

In our study, MRA and SGLT2 inhibitor usage was higher in HFrEF, with spironolactone and dapagliflozin being the most common. Other medications, including oral diuretics, antiplatelets, oral anticoagulants, digitalis, and oral anti-diabetic drugs, varied significantly among the groups. No significant differences were seen in the use of ivabradine, amiodarone, insulin, and COPD treatments.

A study found no disparity in the prescription rates of ACE inhibitors/ARBs, beta-blockers, and MRAs between patients with HFrEF and those with HFpEF as prescribed by coronary care unit (CCU) physicians [(14)]. Conversely, a study reported differences in medication prescriptions among patients with different types of HF. They found that ACE inhibitors were more commonly used in HFrEF and HFmrEF (67% and 61%, respectively), while ARBs were more commonly prescribed to HFpEF patients. There was no significant difference in the prescription rates of MRAs among the three types of HF. Beta-blockers were more frequently prescribed to HFrEF patients. Notably, ARNI was prescribed to only 2% of HFrEF and HFmrEF patients and was not prescribed to any HFpEF patients [(15)].

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In our study, abnormal ECG findings were common in all HF groups but were significantly less frequent in HFpEF compared to HFrEF and HFmrEF. Chest X-rays were less often performed in HFpEF patients, with most abnormalities seen in HFrEF patients.

Echocardiographic findings showed that HFpEF had more left ventricular hypertrophy (LVH) and larger left atrial (LA) diameter and LVEDD. Moderate-to-severe mitral regurgitation (MR) and tricuspid regurgitation (TR) were more common in HFrEF, while moderate-to-severe aortic stenosis (AS) was more frequent in HFpEF.

Coronary angiography was more frequently performed in HFrEF and HFmrEF patients, with higher rates of abnormalities observed in these groups compared to HFpEF. Revascularization attempts, primarily via PCI, were also more common in HFrEF and HFmrEF patients. Non-pharmacological and device-based therapies showed negligible differences among the groups, with pacemaker implantation, CRT, and ICD utilization being infrequent across all groups. A study reported no significant differences regarding CRT, ICD, and pacemaker implantation, aligning with our findings [15].

This study shows promising adherence to ESC guidelines for managing HF, with strong pharmacological adherence, particularly in the use of ACE inhibitors, beta-blockers, MRAs, and SGLT2 inhibitors. Significant ARNI usage in HFrEF patients also reflects alignment with guidelines. However, there is a notable underutilization of device-based therapies like CRT and ICD across all HF subtypes, highlighting a gap in adherence potentially due to socioeconomic and systemic barriers and limited access to advanced care and devices.

Our study had some limitations including that some data were collected through patient interviews, which may introduce recall bias. The study did not account for patients' socioeconomic status, which affects treatment access and adherence. Comorbid conditions may have influenced treatment choices and adherence, complicating the assessment of guideline adherence.

## Conclusion:

Adherence to European HF guidelines is limited in Egyptian patients, with low use of ARNI and SGLT2 inhibitors. High costs, lack of awareness, and comorbidities are major barriers.

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None to declare.

**Author contribution**

The authors contributed equally to the study.

**Conflicts of interest**

None.

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