

EJECTION FRACTION-GUIDED PHARMACOTHERAPY IN CORONARY ARTERY DISEASE: A CROSS-SECTIONAL STUDY OF DIURETIC, RENIN-ANGIOTENSIN SYSTEM INHIBITOR, AND SACUBITRIL/VALSARTAN (ARNI) PRESCRIBING PATTERNSChetak Raghavan^a, Manasa K. S.*^b, Laigin Sebastian^b^aClinical Pharmacist, Department of Cardiology, IQRAA International Hospital and Research Centre, Calicut, Kerala, India.^bDepartment of Pharmacy Practice, Acharya and BM Reddy College of Pharmacy, Rajiv Gandhi University of Health Sciences, Bengaluru, Karnataka, India.***Corresponding Author: Manasa K. S. PharmD Intern**Department of Pharmacy Practice, Acharya and BM Reddy College of Pharmacy, Rajiv Gandhi University of Health Sciences, Bengaluru, Karnataka, India. DOI: <https://doi.org/10.5281/zenodo.22158916>**How to cite this Article:** Chetak Raghavan^a, Manasa K. S.*^b, Laigin Sebastian^b. (2026). Ejection Fraction-Guided Pharmacotherapy In Coronary Artery Disease: A Cross-Sectional Study Of Diuretic, Renin-Angiotensin System Inhibitor, And Sacubitril/Valsartan (Arni) Prescribing Patterns. European Journal of Pharmaceutical and Medical Research, 13(9), 196–201. This work is licensed under Creative Commons Attribution 4.0 International license.

Article Received on 28/07/2026

Article Revised on 18/08/2026

Article Published on 01/09/2026

ABSTRACT

Background: Left ventricular (LV) systolic function, quantified by ejection fraction (EF), is a key determinant of pharmacotherapy selection in coronary artery disease (CAD), guiding the use of diuretics, renin-angiotensin system (RAS) inhibitors, and, in patients with markedly reduced EF, the angiotensin receptor-neprilysin inhibitor (ARNI) sacubitril/valsartan. Real-world data on how closely EF-stratified prescribing in Indian tertiary-care practice aligns with guideline-directed therapy remain limited. **Objective:** To evaluate the distribution of ejection fraction categories among CAD patients and to characterize the utilization pattern of diuretics, ACE inhibitors/ARBs, and ARNI across these categories, alongside adherence to ACC/AHA guideline-directed prescribing. **Methods:** A hospital-based, cross-sectional, observational study was conducted over three months at a tertiary-care cardiology center in Kakinada, India. One hundred patients with confirmed CAD were enrolled by random sampling. Ejection fraction was determined by two-dimensional echocardiography, and prescription data for diuretics, RAS inhibitors, and ARNI were extracted from medical records and analyzed against EF category and ACC/AHA guideline concordance. **Results:** Mild-to-moderate LV dysfunction (EF 30–50%) was the most common finding, present in 38% of patients, followed by preserved EF ≥60% (29%), EF 50–60% (31%), and severely reduced EF ≤30% (2%). Diuretics were prescribed in 59% of patients overall and were the most frequently used drug class specifically among those with LV dysfunction, with torsemide (30.43%), spironolactone (29.34%), and furosemide (28.26%) the leading individual agents. ARNI (sacubitril/valsartan) was reserved exclusively for the 2% of patients with EF below 30%, reflecting guideline-concordant, EF-stratified escalation of therapy. Renin-angiotensin system blockade was achieved predominantly through ARBs (26% of patients; telmisartan 73.07% of ARB use) rather than ACE inhibitors (8% of patients). Guideline-directed prescribing, benchmarked against ACC/AHA recommendations, showed high concordance: statins 98.1%, dual antiplatelet therapy 97.5%, beta-blockers 96.8%, ACE inhibitors/ARBs 95.6%, and nitrates 84%. **Conclusion:** Pharmacotherapy in this CAD cohort was meaningfully stratified by ejection fraction, with diuretic intensification in LV dysfunction and reservation of ARNI for severely reduced EF, in keeping with ACC/AHA heart failure and CAD management guidelines. The comparatively lower use of ACE inhibitors relative to ARBs and the somewhat lower guideline concordance for nitrate therapy represent areas warranting closer prescribing review.

KEYWORDS: Ejection fraction; left ventricular dysfunction; coronary artery disease; diuretics; renin-angiotensin system inhibitors; sacubitril/valsartan; ARNI; drug utilization.

1. INTRODUCTION

Coronary artery disease (CAD) frequently coexists with, or progresses to, some degree of left ventricular (LV) systolic dysfunction, which has direct implications for pharmacological management. Ejection fraction (EF), measured by two-dimensional echocardiography, is the principal parameter used to stratify LV function into normal ($EF \geq 55\%$), mild dysfunction ($EF 45\text{--}54\%$), moderate dysfunction ($EF 36\text{--}44\%$), and severe dysfunction ($EF \leq 35\%$). This stratification is not merely diagnostic; it is central to therapeutic decision-making, since guideline-directed medical therapy for heart failure with reduced ejection fraction (HFrEF) differs substantially from that for CAD patients with preserved LV function.

Diuretics remain the mainstay for managing volume overload and congestive symptoms in patients with reduced EF, while renin–angiotensin system (RAS) blockade—via ACE inhibitors or angiotensin receptor blockers (ARBs)—provides both symptomatic and mortality benefit across the spectrum of LV dysfunction. More recently, the angiotensin receptor–neprilysin inhibitor (ARNI) combination sacubitril/valsartan has been incorporated into guideline-directed therapy specifically for patients with markedly reduced ejection fraction, offering superior outcomes over ACE inhibitor/ARB therapy alone in this subgroup. Because ARNI is a relatively costly and more recently introduced therapy, its real-world uptake and the degree to which its use is appropriately confined to patients with severely reduced EF is of considerable interest to both clinicians and health-system planners.

Despite the well-established pathophysiological rationale for EF-stratified pharmacotherapy, few Indian drug utilization studies have explicitly examined how prescribing of diuretics, RAS inhibitors, and ARNI tracks with measured ejection fraction in a real-world CAD population, or how closely such prescribing adheres to ACC/AHA guideline recommendations across drug classes. This study addresses that gap by analyzing the distribution of ejection fraction categories in a cohort of CAD patients and characterizing the corresponding utilization pattern of EF-relevant drug classes, alongside a broader assessment of guideline concordance.

1.1 Objectives

- To determine the distribution of ejection fraction categories among patients with CAD.
- To characterize the utilization pattern of diuretics across EF categories, including agent-level prescribing within the diuretic class.
- To evaluate the pattern of renin–angiotensin system blockade (ACE inhibitors versus ARBs) and the utilization of ARNI (sacubitril/valsartan) in relation to ejection fraction.
- To assess adherence of EF-relevant and other cardiovascular drug prescribing to ACC/AHA guideline recommendations.

2. MATERIALS AND METHODS

2.1 Study Design and Setting

A hospital-based, observational, cross-sectional study was conducted in the Department of Cardiology at Trust Hospital, Kakinada, Andhra Pradesh, India, over a period of three months.

2.2 Study Population and Sampling

Of 134 patients with confirmed CAD screened, 100 eligible patients were enrolled by random sampling after applying inclusion and exclusion criteria; 34 were excluded due to lack of time ($n = 23$), disinterest ($n = 8$), or recent diagnosis ($n = 3$).

Inclusion criteria: Patients of either gender with a confirmed diagnosis of CAD.

Exclusion criteria: Pregnant and lactating women; patients younger than 20 or older than 80 years; patients admitted with other primary cardiac diagnoses.

2.3 Assessment of Ejection Fraction

Ejection fraction was measured by two-dimensional echocardiography (2D-ECHO), performed in all 100 patients, and categorized as $\leq 30\%$, $30\text{--}50\%$, $50\text{--}60\%$, and $\geq 60\%$. Coronary angiography (CAG) was additionally performed in a subset of patients (67%) to characterize the extent of coronary vessel involvement.

2.4 Data Collection

Demographic details, echocardiographic findings, and complete prescription data (drug name, class, dose) were extracted from patients' case records using a structured data collection form. Prescriptions were classified by pharmacological category, and diuretic, RAS inhibitor, and ARNI prescribing was cross-tabulated against the patient's recorded ejection fraction category.

2.5 Assessment of Guideline Concordance

Prescribing of dual antiplatelet therapy, statins, ACE inhibitors/ARBs, beta-blockers, and nitrates was assessed for concordance with American College of Cardiology/American Heart Association (ACC/AHA) treatment guidelines for CAD and, where applicable, heart failure management.

2.6 Statistical Analysis

Descriptive statistics (frequencies, percentages, mean $\pm$ standard deviation) were used to summarize EF distribution and drug utilization data. Associations between ejection fraction distribution and gender were explored using the chi-square test and one-way ANOVA, with statistical significance set at $p < 0.05$.

2.7 Ethical Considerations

The study used routinely collected clinical data with patient consent and maintained confidentiality throughout data collection and analysis, in accordance with applicable ethical standards for observational research.

3. RESULTS

3.1 Distribution of Ejection Fraction

Among the 100 CAD patients evaluated by 2D-echocardiography, mild-to-moderate LV dysfunction (EF 30–50%) was the most common finding, observed in 38% of patients, followed by EF 50–60% (31%), preserved EF $\geq 60\%$ (29%), and severely reduced EF $\leq 30\%$ (2%). Restated by severity category, mild LV

dysfunction was present in 8% and mild-to-moderate dysfunction in 28% of the cohort, with severe LV dysfunction comparatively rare (2%). By gender, males predominated in the EF 30–50% category (25 of 38 patients, 65.78%) and the EF 50–60% category (20 of 31, 64.51%), while both patients with EF $\leq 30\%$ were female.

Table 1: Distribution of ejection fraction among CAD patients (n = 100).

Ejection fraction category	Patients (n)	% of total	Male, n (%)	Female, n (%)
$\leq 30\%$ (severe LV dysfunction)	2	2.0	0 (0%)	2 (100%)
30–50% (mild–moderate LV dysfunction)	38	38.0	25 (65.78%)	13 (34.22%)
50–60%	31	31.0	20 (64.51%)	11 (35.49%)
$\geq 60\%$ (preserved)	29	29.0	17 (58.62%)	12 (41.38%)

3.2 Diuretic Utilization in Relation to LV Dysfunction

Diuretics were prescribed in 59% of the overall cohort and constituted 92 of 627 total cardiovascular drug prescriptions (14.67%), the third-largest drug-class contribution after antiplatelets and statins. Diuretics were the most prescribed drug class specifically among patients with LV dysfunction, consistent with their established role in managing volume overload in this subgroup. Within the diuretic class, torsemide (30.43%),

spironolactone (29.34%), and furosemide (28.26%) were the leading individual agents, with chlorthalidone, eplerenone, and amiloride used less frequently. The prominent use of spironolactone (a potassium-sparing, aldosterone-antagonist diuretic) alongside loop diuretics reflects a treatment approach consistent with guideline-directed therapy for LV dysfunction, in which mineralocorticoid receptor antagonists provide additional mortality benefit beyond diuresis alone.

Table 2: Utilization pattern of diuretic agents (n = 92 diuretic prescriptions).

Diuretic agent	No. of prescriptions	% within diuretic class
Torsemide	28	30.43
Spironolactone	27	29.34
Furosemide	26	28.26
Eplerenone	5	5.43
Chlorthalidone	4	4.34
Amiloride	2	2.17

3.3 Renin–Angiotensin System Blockade: ACE Inhibitors versus ARBs

RAS blockade was achieved predominantly through angiotensin receptor blockers rather than ACE inhibitors. ARBs were prescribed in 26% of patients (27 prescriptions), with telmisartan the leading agent (73.07% of ARB prescriptions), followed by olmesartan

(19.23%) and losartan (7.69%). ACE inhibitors were used in only 8% of patients, with enalapril (62.5%) more frequently prescribed than ramipril (37.5%). This more than three-fold preference for ARBs over ACE inhibitors may reflect prescriber preference for the more favorable cough/tolerability profile of ARBs in this population.

Table 3: Renin–angiotensin system inhibitor utilization pattern.

Drug class	Agent	No. of prescriptions	% within class
ARB (n = 26 patients)	Telmisartan	19	73.07
	Olmesartan	5	19.23
	Losartan	2	7.69
ACE inhibitor (n = 8 patients)	Enalapril	5	62.5
	Ramipril	3	37.5

3.4 ARNI (Sacubitril/Valsartan) Utilization in Severely Reduced Ejection Fraction

ARNI therapy with sacubitril/valsartan was prescribed in exactly 2% of the overall cohort (2 of 100 patients), and this usage corresponded precisely to the 2 patients with ejection fraction below 30%—that is, ARNI use in this cohort was confined entirely to the severe LV dysfunction subgroup, with 100% of ARNI prescriptions

occurring in EF $\leq 30\%$ patients and no ARNI use observed in patients with EF $\geq 30\%$. This pattern demonstrates strict EF-stratified prescribing consistent with guideline recommendations restricting ARNI initiation to patients with markedly reduced ejection fraction, where its benefit over conventional RAS blockade is best established.

3.5 Adherence to ACC/AHA Guideline-Directed Therapy

Prescribing concordance with ACC/AHA guidelines was high across major drug classes: statins 98.1%, dual antiplatelet therapy 97.5%, beta-blockers 96.8%, ACE inhibitors/ARBs 95.6%, and nitrates 84.0%. Nitrate therapy showed the lowest guideline concordance among

the classes assessed, suggesting a modest opportunity for improvement in antianginal prescribing relative to the otherwise high overall adherence. The average number of drugs prescribed per patient was 6.2 ± 1.18 , and the overall drug utilization review estimated 98.05% rationality in therapy with respect to dose, route of administration, and dosage form.

Table 4: Prescription compliance with ACC/AHA guidelines by drug class.

Drug class	Compliant with guideline (%)	Non-compliant (%)
Statins	98.1	1.9
Dual antiplatelet therapy (DAPT)	97.5	2.5
Beta-blockers	96.8	3.2
ACE inhibitors / ARBs	95.6	4.4
Nitrates	84.0	16.0

4. DISCUSSION

This study demonstrates that pharmacotherapy in this CAD cohort was meaningfully stratified by ejection fraction, in line with the pathophysiological rationale underpinning contemporary heart failure and CAD management guidelines. The predominance of mild-to-moderate LV dysfunction (EF 30–50%, 38% of patients) over severely reduced EF (2%) reflects the expected distribution in a general CAD population, in which severe systolic dysfunction represents a minority but clinically critical subgroup requiring the most intensive pharmacological intervention.

The finding that diuretics were the most heavily utilized drug class among patients with LV dysfunction, with loop diuretics (torsemide, furosemide) and the mineralocorticoid receptor antagonist spironolactone forming the leading agents, is consistent with established heart failure pharmacotherapy principles: loop diuretics for symptomatic volume control, and spironolactone for its additional neurohormonal and mortality benefit in reduced-EF populations. The near-equal utilization of torsemide, spironolactone, and furosemide (each accounting for roughly 28–30% of diuretic prescriptions) suggests a balanced, combination-based approach to diuretic therapy rather than reliance on a single agent class.

The marked preference for ARBs over ACE inhibitors (26% versus 8% of patients) is a notable prescribing pattern. While ACE inhibitors and ARBs are considered broadly equivalent in efficacy for RAS blockade in CAD and heart failure, ACE inhibitors are often positioned as first-line therapy in major guidelines, with ARBs reserved for ACE inhibitor-intolerant patients (e.g., due to cough). The more than three-fold higher use of ARBs in this cohort may reflect local prescriber preference, patient tolerability considerations, or the specific tertiary-care referral population studied, and represents a pattern that merits further investigation regarding underlying prescribing rationale.

Perhaps the most clinically reassuring finding was the precise concordance between ARNI utilization and

severe LV dysfunction: sacubitril/valsartan was prescribed exclusively in the two patients with EF below 30%, with no use observed in any patient with better-preserved ejection fraction. This tight EF-stratified restriction of ARNI use aligns with guideline recommendations that reserve this comparatively costlier and more recently introduced therapy for the subgroup of patients in whom its incremental benefit over conventional RAS blockade is most strongly evidenced, and suggests judicious, evidence-based prescribing behavior at this center rather than indiscriminate adoption of newer therapy.

The overall high guideline concordance observed—exceeding 95% for statins, DAPT, beta-blockers, and ACE inhibitors/ARBs—supports the broader conclusion that prescribing practice at this center is largely rational and evidence-based. The comparatively lower concordance for nitrate therapy (84%) is the one area where guideline adherence notably lagged behind other drug classes, and may reflect either more variable clinical indications for antianginal therapy (which is more symptom-driven than the largely indication-independent use of statins or antiplatelets) or an opportunity for more consistent application of nitrate prescribing criteria.

Taken together, these findings support the value of routine ejection fraction assessment as a structural driver of rational, guideline-concordant pharmacotherapy in CAD, and highlight diuretic combination strategies and judicious ARNI reservation for severe LV dysfunction as particular strengths of prescribing practice in this setting.

4.1 Limitations

This study was conducted at a single tertiary-care hospital over a three-month period with a modest sample size of 100 patients, and the severely reduced EF subgroup ($n = 2$) was too small to permit robust statistical comparison of drug utilization within that category. Ejection fraction was recorded as a categorical variable from echocardiography reports rather than analyzed as a continuous measure, which may have limited the granularity of dose-response or threshold-

based prescribing analysis. Larger, multicentric studies with greater representation of severe LV dysfunction are needed to confirm and extend these findings.

5. CONCLUSION

Pharmacotherapy in this CAD cohort was substantially guided by ejection fraction, with diuretic combination therapy—including loop diuretics and spironolactone—predominating in patients with LV dysfunction, and ARNI (sacubitril/valsartan) use precisely confined to patients with severely reduced ejection fraction. Renin-angiotensin system blockade favored ARBs over ACE inhibitors, and overall adherence to ACC/AHA guideline-directed therapy was high across major drug classes, with nitrate prescribing representing the principal area for potential improvement. These findings support ejection fraction as a key clinical driver of rational, evidence-based cardiovascular prescribing and underscore the importance of routine echocardiographic assessment in guiding individualized pharmacotherapy in CAD.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

REFERENCES

1. 15% of death in India were due to heart disease in 1990; now up to 28%. Toufiq Rashid. Business Standard, Sep 18, 2018.
2. A study of clinical profile of acute ST elevation myocardial infarction patients from GMERS Medical College and Hospital, Gandhinagar, Gujarat. Chirayu V. Vaidya*, Drusty K. Majmudar.
3. A study of drug utilization pattern in post-acute coronary syndrome (ACS) patients at tertiary care teaching hospital: a prospective unicentric study. Vidhi Thaker*, Kamlesh Patel.
4. A study of Risk Factors in Young Patients of Acute Coronary Syndrome. Saumya Gupta, Krishna K. Lakhani, Hirava Munshi.
5. A study on prescription pattern of cardiovascular drugs in inpatient department at a tertiary care centre. Divya Amaravadi, Srinivas Laxmapuram, Sonali Sabavat, Vasudha Bakshi, Narender Boggula.
6. A systemic review of prescription pattern monitoring studies and their effectiveness in promoting rational use of medicine. Shipra Jain, Perna Upadhyaya. Perspect Clin Res., Apr-Jun, 2015; 6(2): 86-90.
7. Acute Coronary Syndrome (ACS) in the Young: Angiographic Features and Risk Factor Analysis of Patients with ACS before the Age of 35 Years. Wani MI, Rashid A, Beig JR, Ajaz S. International Journal of Scientific Study, 2017; 5(4): 244-8.
8. Adherence to Prescription Format and Compliance with WHO Core Prescribing Indicators. H.S. Babar, S. Hussain, Z. Maqsood, H.A. Dad, M. Khan, A.A. Rahman, A. Bukhsh.
9. An Australian comparison of specialist care of acute myocardial infarction. International Journal for Quality in Health Care. Scott IA, Heath K, Harper C, Clough A., 2003; 15(2): 155-61.
10. Analysis of drug prescribing pattern and sociodemographic background in patients with Coronary Artery Disease in a tertiary care hospital. Swathi M, Akhilendran R, Hima M, Fahida F, Veena V, Pradeep P. EJPMR, 2016; 3(11): 352-8.
11. Cardiovascular disease prevalence and prescription patterns at a tertiary level hospital. Leenah Almonshatih Dirar Ali, 2017.
12. Cardiovascular disease prevalence and prescription patterns at a tertiary level hospital in Bangladesh. Journal of Applied Pharmaceutical Science. Muhit MA, Rahman MO, Raihan SZ, Asaduzzaman M, Akbar MA, Sharmin N, et al., 2012; 2(3): 8.
13. Change in prevalence of Coronary Heart Disease and its risk between 1991-94 to 2010-12 among rural and urban population of National Capital Region, Delhi. Anand Krishnan, Md Asadullah, Ambuj Roy, Pradeep A. Praveen, Kalpana Singh, Ritvik Amarchand, Ruby Gupta, Lakshmy Ramakrishnan, Dimple Kondal, Nikhil Tandon, Meenakshi Sharma, Deepak Kumar Shukla, Dorairaj Prabhakaran, Kolli Srinath Reddy.
14. Clinical Management Guidelines for Coronary Artery Disease for National Programme and Control of Diabetes, Cardiovascular Disease and Stroke. Talwar KK, Yash PS, Thakur JS, Rajiv M, Shiv B. Government of India-WHO; Collaborative Programme 2008-2009. 2017.
15. Clinical profile and outcomes of patients presenting with acute coronary syndrome in a tertiary care hospital. Vijay K. Kadam.
16. Clinical Profile and Risk Factors Associated with Acute Myocardial Infarction. T.N. Prasad, M.K. Kumari.
17. Clinical profile and risk factors in acute coronary syndrome. Singh PS, Singh G, Singh SK. Chest., 2013; 180: 90.
18. Clinical profile and risk factors in acute coronary syndrome. Yadav P, Joseph D, Joshi P, Sakhi P, Jha RK, Gupta J. National J Comm Med., 2010; 1(2): 150.
19. Coronary Artery Disease. Erum S. Kabani, 2008.
20. Coronary artery disease. Centers for Disease Control and Prevention, Dec 9, 2019.
21. Coronary artery disease. Cleveland Clinic, 21 June, 2021.
22. Coronary artery disease. Mayo Clinic, June 05, 2020.
23. Coronary artery disease. Rai Dilawar Shehjeahan. StatPearls, 2 July, 2021.
24. Coronary heart disease and risk factors in India, On the brink of an epidemic? M.N. Krishnan.
25. Differential diagnosis and medical therapeutics – A treatise on clinical medicine by P. Siva Rama Krishna Rao.
26. Does the pharmacological management of unstable angina vary with age and gender – a descriptive study. Journal of Clinical and Diagnostic Research.

- Banerjee S, Kumar V, Ramachandran P, Kamath A., 2010; 4: 3150-7.
27. Drug Utilization Pattern in Cardiovascular Diseases: A Descriptive Study in Tertiary Care Settings in Pakistan. Zafar F, Ali H, Naveed S, Korai OU, Rizvi M, Naqvi GR and Siddiqui S.