Section: Pharmacology

Original Research Article

DRUG UTILISATION PATTERN AND GUIDELINE CONCORDANCE IN AMBULATORY PATIENTS WITH HEART FAILURE AT A GOVERNMENT TERTIARY CARE TEACHING HOSPITAL IN EASTERN INDIA: A CROSS-SECTIONAL STUDY

Ratul Paul[1], Ayan Pal[2], Purnendu Mandal[3*]

[1]Assistant Professor, Department of Pharmacology, Institute of Post Graduate Medical Education & Research, Kolkata, West Bengal, India.
[2]Associate Professor, Department of Pharmacology, NRS Medical College and Hospital, Kolkata, West Bengal, India.
[3]Assistant Professor, Department of Phamacology, Jhargram Government Medical College & Hospital, Vidyasagar Pally, Jhargram, Dist. Jhargram, West Bengal, India.

Received *: 10/10/2026*
Received in revised form *: 03/11/2026*
Accepted *: 17/11/2026*

Corresponding Author:
Dr. Purnendu Mandal,
Assistant Professor, Department of Phamacology, Jhargram Government Medical College & Hospital, Vidyasagar Pally, Jhargram, Dist. Jhargram, West Bengal, India
Email: bmpurnendu619@gmail.com

DOI: 10.70034/ijmedph.2026.4.369

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (4); 2449-2457

ABSTRACT

Background: Heart failure (HF) is treated with several drug classes, yet prescribing patterns and dose adequacy in Indian public-sector outpatient settings remain poorly documented. The objective is to describe drug utilisation in ambulatory patients with HF and to compare prescribing with contemporaneous ACC/AHA guidelines.

Materials and Methods: This cross-sectional drug utilisation study was conducted in the cardiology outpatient department of a government teaching hospital in Kolkata (January 2018–June 2019). Consecutive patients aged 20–70 years with NYHA class I–II HF were enrolled. Prescriptions were analysed with WHO prescribing indicators and the ATC/DDD methodology; prescribed daily dose (PDD)/DDD ratios and drug utilisation 90% (DU90%) were calculated.

Results: Of 356 patients (mean age 57.95 ± 7.61 years; 65.4% men; 54.5% rural), 65.2% had reduced ejection fraction. All patients received a renin–angiotensin system blocker (ramipril 93.3%, angiotensin receptor blocker 6.7%) and a loop diuretic; 53.4% received a beta-blocker, 53.1% spironolactone, 45.5% atorvastatin and 13.5% digoxin. Beta-blocker doses were low (PDD/DDD 0.13 for metoprolol and 0.14 for carvedilol); no patient reached 50% of the target beta-blocker dose, and 12.7% of ramipril users received the 10 mg target dose. DU90% comprised ramipril, furosemide, atorvastatin, torasemide and spironolactone. Mean drugs per encounter were 4.39; 12.4% of drugs were prescribed generically and 50.0% from the essential medicines list; no antibiotic or injection was prescribed. Mean drug cost was INR 42.23 per day.

Conclusion: Drug-class selection broadly followed guidelines, but beta-blocker under-dosing, sparse generic prescribing and partial essential-medicine use show clear scope for dose optimisation and cost containment.

Keywords: Heart failure, Drug utilisation, Defined daily dose, DU90%, Prescribing indicators, Guideline adherence, India

INTRODUCTION

Heart failure (HF) is a growing global public-health problem, affecting an estimated 64 million people worldwide, with a prevalence that rises steeply with age and a persistently high burden of hospitalisation and death.[1] In India, the true incidence and prevalence of HF are uncertain because population-based surveillance is lacking. Model-based estimates derived from the prevalence of coronary heart disease, hypertension, diabetes, obesity and rheumatic heart disease suggest that between 1.3 and

4.6 million Indians live with HF, with an annual incidence of roughly 0.5–1.8 million.[2] India carries a double burden: rising rates of conventional cardiovascular risk factors coexist with the persistence of rheumatic heart disease, endomyocardial fibrosis, tuberculous pericardial disease and anaemia, while the population is ageing.[2]

Indian patients develop HF about a decade earlier than patients in high-income countries, and outcomes are poor. In the Trivandrum Heart Failure Registry, patients were younger than in Western registries, and in-hospital and 90-day mortality were substantial.[3] The multicentre National Heart Failure Registry, which enrolled 10 851 patients from 53 tertiary centres, reported that only about half of eligible patients received guideline-directed medical therapy (GDMT) and that patients not receiving GDMT had higher 90-day mortality.[4] The international INTER-CHF cohort also showed wide regional variation in HF mortality, which was high in India and other low- and middle-income settings.[5] These observations suggest that gaps in prescribing, and not only gaps in access to care, contribute to outcomes.

Drug utilisation research evaluates the marketing, distribution, prescription and use of medicines in society, with particular attention to their medical, social and economic consequences.[6] Its central aim is to judge whether therapy is rational. Two tools developed under the World Health Organization (WHO) are widely used for this purpose. The first is the set of core prescribing indicators, which describe polypharmacy, generic prescribing, use of antibiotics and injections, and adherence to an essential medicines list.[7] The second is the Anatomical Therapeutic Chemical (ATC) classification with its technical unit of measurement, the defined daily dose (DDD), which allows drug consumption to be compared across settings independently of price and pack size.[8] Ranking drugs by DDD volume and identifying those that account for 90% of use (DU90%) provides a simple, transferable indicator of prescribing quality.[9]

Treatment of HF necessarily involves polypharmacy. Contemporary guidelines at the time of this study recommended an angiotensin-converting enzyme inhibitor (ACEI) or angiotensin receptor blocker (ARB), an evidence-based beta-blocker, loop diuretics for congestion, an aldosterone antagonist in selected patients and digoxin for persistent symptoms.[10] Each class must not only be prescribed but titrated to target doses shown to improve outcomes in clinical trials.[11–15] International registries show that under-dosing is common even in high-income countries.[16,17] In Indian government teaching hospitals, adherence to such guidelines may be further limited by constrained resources, infrastructure and the low purchasing power of most patients. Data on outpatient HF prescribing, dose adequacy and cost in this setting are scarce.

We therefore conducted a drug utilisation study among ambulatory patients with HF attending a government tertiary care teaching hospital in eastern India. The primary objective was to describe the drug utilisation pattern, including drug classes, individual agents and doses. The secondary objective was to compare prescribing with contemporaneous international guidelines, using WHO prescribing indicators, PDD/DDD ratios, DU90% and attainment of guideline target doses.

MATERIALS AND METHODS

Study design and reporting: This was a prospective, single-centre, cross-sectional drug utilisation study. Each participant contributed a single prescribing encounter. The manuscript is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for cross-sectional studies.[18]

Setting: The study was conducted jointly by the Department of Pharmacology and the Cardiology outpatient department (OPD) of R.G. Kar Medical College and Hospital, Kolkata, West Bengal, a government medical teaching institute that serves a largely low- and middle-income population from urban Kolkata and surrounding rural districts. The study ran from January 2018 to June 2019 (18 months). Participant recruitment took place during the first six months (January 2018–June 2019); the remaining period was used for data verification, analysis and report preparation. No interim analysis was planned.

Participants: All consecutive patients with HF attending the Cardiology OPD during the recruitment period were screened. Patients aged 20–70 years were eligible if they had a diagnosis of HF based on the Framingham criteria,[19] and/or echocardiography and were in New York Heart Association (NYHA) functional class I or II at the index visit. This included newly diagnosed patients and patients who had presented in NYHA class III or IV but had improved to class I or II on treatment and were being followed up as outpatients. Patients who required hospitalisation for any reason (including NYHA class III or IV HF) and pregnant women were excluded. Patients were classified as having HF with reduced ejection fraction (HFrEF; left ventricular ejection fraction [LVEF] < 40%) or HF with LVEF ≥ 40%.

Variables and data sources: After the consultation, every prescription issued to an enrolled patient was intercepted and transcribed onto a pre-tested case record form adapted from the WHO manual on investigating drug use in health facilities.[7] Patient variables were age, sex, place of residence (rural or urban), monthly household income, body mass index (BMI), LVEF category and comorbidities (diabetes mellitus, hypertension, smoking history and chronic kidney disease). Prescribing variables were the generic and brand name, dose, frequency and duration of every drug prescribed. The WHO core prescribing indicators.[7] were calculated as follows: average number of drugs per encounter; percentage of drugs prescribed by generic name; percentage of

encounters with an antibiotic; percentage of encounters with an injection; and percentage of drugs prescribed from the National List of Essential Medicines of India or the hospital formulary. The average drug cost per encounter was calculated as the daily cost of all prescribed drugs at prevailing retail prices.

Each drug was classified using the WHO ATC/DDD system.[8] The prescribed daily dose (PDD) was the average daily dose prescribed to users of a drug. The PDD/DDD ratio was calculated for every HF drug; a ratio above 1 indicates prescribing above, and a ratio below 1 prescribing below, the WHO-assigned DDD. Drug consumption was expressed as the total number of DDDs dispensed per day and as DDDs per 100 patients per day. Drugs were ranked by DDD volume, and those accounting for 90% of total DDDs formed the DU90% segment.[9] For the main HF drug classes, the proportion of users receiving at least 50% of, and the full, guideline target dose was determined using target doses from the ACC/AHA guideline.[10] (ramipril 10 mg/day; metoprolol succinate 200 mg/day; carvedilol 50 mg/day; losartan 150 mg/day; spironolactone 25–50 mg/day). Guideline concordance at the class level was judged against the 2009 ACC/AHA focused update, which was the current guidance during the study.[10]

Bias: Selection bias was minimised by enrolling all consecutive eligible patients rather than a convenience sample. Information bias was minimised by recording prescriptions directly at the point of issue, before dispensing, using a standardised form; investigators did not influence prescribing. Because the observing department (Pharmacology) was independent of the prescribing department (Cardiology), the risk of a Hawthorne effect on prescribers was considered low but cannot be excluded.

Study size: No formal sample size was calculated; all eligible patients seen during the recruitment period were included. With 356 participants, a prescribing proportion of 50% can be estimated with a 95% confidence interval (CI) half-width of ±5.2 percentage points, which was considered adequate for a descriptive drug utilisation study.

Statistical methods: Data were entered into a spreadsheet, cleaned and locked before analysis, and analysed in the Department of Pharmacology. Continuous variables are summarised as mean ± standard deviation (SD) and categorical variables as frequency and percentage. For the manuscript, 95% CIs for proportions were calculated by the Wilson score method. Analyses were descriptive, as the objectives were to characterise and benchmark prescribing; no hypothesis testing or subgroup comparisons were planned. All denominators equalled the enrolled sample unless otherwise stated, and no imputation was required.

Ethical considerations: The study protocol, case record form and informed consent form (in Bengali, Hindi and English) were approved by the Institutional Ethics Committee of R.G. Kar Medical College and Hospital, Kolkata, before recruitment began. Written informed consent was obtained from all participants; patients unable to write gave a left-thumb impression in the presence of an impartial witness after the study was explained in their own language. The study was conducted in accordance with the Declaration of Helsinki. Study documents were archived by the principal investigator in the Department of Pharmacology.

RESULTS

Participants and descriptive data: A total of 356 patients were enrolled and all were included in the analysis. Their characteristics are shown in [Table 1]. The mean age was 57.95 ± 7.61 years; 307 patients (86.2%) were older than 50 years, and the proportion rose with each decade, from 3.9% at 31–40 years to 46.6% at 61–70 years. No patient was younger than 30 years. There were 233 men (65.4%) and 123 women (34.6%), a male-to-female ratio of 1.89:1. More than half (194, 54.5%) lived in rural areas. The mean monthly household income was INR 11 043 (range 3000–24 000), and the mean BMI was 22.12 kg/m². Most patients (232, 65.2%) had HFrEF. Smoking history (28.9%), diabetes mellitus (25.8%), hypertension (21.9%) and chronic kidney disease (7.3%) were the main comorbidities.

Table 1: Demographic and clinical characteristics of the study participants (n = 356)

Characteristic	Value
Age, years, mean ± SD	57.95 ± 7.61
31–40 years, n (%)	14 (3.93)
41–50 years, n (%)	35 (9.83)
51–60 years, n (%)	141 (39.61)
61–70 years, n (%)	166 (46.63)
Sex, n (%)	
Male	233 (65.45)
Female	123 (34.55)
Male : female ratio	1.89 : 1
Residence, n (%)	
Rural	194 (54.49)
Urban	162 (45.51)
Monthly household income, INR, mean (range)	11 043 (3000–24 000)
Body mass index, kg/m², mean	22.12
Ejection fraction category, n (%)	
Reduced (LVEF < 40%)	232 (65.17)

LVEF ≥ 40%	124 (34.83)
NYHA functional class at study visit	I–II (all)
Comorbidities, n (%) [95% CI]	
Smoking history	103 (28.93) [24.5–33.8]
Diabetes mellitus	92 (25.84) [21.6–30.6]
Hypertension	78 (21.91) [17.9–26.5]
Chronic kidney disease	26 (7.30) [5.0–10.5]

CI, confidence interval (Wilson score); INR, Indian rupee; LVEF, left ventricular ejection fraction; NYHA, New York Heart Association; SD, standard deviation.

Pattern of drug use: Drug use by class and agent is summarised in [Table 2 and Figure 1]. The ten most frequently prescribed drugs were ramipril (93.3%), furosemide (68.8%), spironolactone (53.1%), atorvastatin (45.5%), metoprolol (33.1%), torasemide (31.2%), aspirin (23.6%), carvedilol (20.2%), alprazolam (17.4%) and pantoprazole (13.5%). Every patient received a renin–angiotensin system blocker. Ramipril was the only ACEI used (332 patients, 93.3%); the most common daily dose was 5 mg (47.6% of users), followed by 2.5 mg (31.9%). The remaining 24 patients (6.7%) received an ARB, either losartan (18 patients; 25 or 50 mg/day) or telmisartan (6 patients; 40 mg/day). All 24 ARB users reported previous ACEI-induced dry cough. Every patient also received a loop diuretic: furosemide in 245 (68.8%), mostly at 20–40 mg/day, and torasemide in 111 (31.2%), mostly at 10 mg/day. No patient received both.

Beta-blockers were prescribed to 190 patients (53.4%): sustained-release metoprolol succinate to 118 (12.5 or 25 mg/day) and carvedilol to 72 (3.125 or 6.25 mg/day). Spironolactone was the only aldosterone antagonist used (189 patients, 53.1%), most often at 25 mg/day; eplerenone was not prescribed. Digoxin 0.125 mg/day was prescribed to 48 patients (13.5%). Atorvastatin, the only statin used, was prescribed to 162 patients (45.5%), mostly at 10–20 mg/day. Among other drugs, aspirin was prescribed to 84 patients (23.6%), clopidogrel to 32 (9.0%), organic nitrates to 36 (10.1%), amlodipine to 34 (9.6%) and nicorandil to 12 (3.4%). Drugs without a recognised survival benefit in HF were common: alprazolam was prescribed to 62 patients (17.4%), pantoprazole to 48 (13.5%) and famotidine to 36 (10.1%). Comorbidities were treated with insulin, metformin or glimepiride (diabetes), levothyroxine (hypothyroidism) and calcium supplements (chronic kidney disease).

Table 2: Drug utilisation by class and agent among patients with heart failure (n = 356)

Drug class / agent	n (%)	95% CI (%)	Daily dose distribution among users, n (%)
ACE inhibitor	332 (93.26)	90.2–95.4	
Ramipril	332 (93.26)	90.2–95.4	1.25 mg: 26 (7.83); 2.5 mg: 106 (31.93); 5 mg: 158 (47.59); 10 mg: 34 (10.24); 20 mg: 8 (2.41)
Angiotensin receptor blocker	24 (6.74)	4.6–9.8	
Losartan	18 (5.06)	—	25 mg: 12 (66.67); 50 mg: 6 (33.33)
Telmisartan	6 (1.69)	—	40 mg: 6 (100)
Loop diuretic	356 (100)	98.9–100	
Furosemide	245 (68.82)	63.8–73.4	20 mg: 95 (38.78); 40 mg: 104 (42.45); 80 mg: 46 (18.77)
Torasemide	111 (31.18)	26.6–36.2	10 mg: 89 (80.18); 20 mg: 22 (19.82)
Beta-blocker	190 (53.37)	48.2–58.5	
Metoprolol succinate (SR)	118 (33.15)	28.5–38.2	12.5 mg: 47 (39.83); 25 mg: 71 (60.17)
Carvedilol	72 (20.22)	16.4–24.7	3.125 mg: 26 (36.11); 6.25 mg: 46 (63.89)
Aldosterone antagonist			
Spironolactone	189 (53.09)	47.9–58.2	12.5 mg: 23 (12.17); 25 mg: 95 (50.26); 50 mg: 71 (37.57)
Cardiac glycoside			
Digoxin	48 (13.48)	10.3–17.4	0.125 mg: 48 (100)
Statin			
Atorvastatin	162 (45.51)	40.4–50.7	10 mg: 58 (35.80); 20 mg: 73 (45.06); 40 mg: 23 (14.20); 80 mg: 8 (4.94)
Other cardiovascular drugs			
Aspirin	84 (23.60)	19.5–28.3	—
Nitrates	36 (10.11)	7.4–13.7	—
Amlodipine	34 (9.55)	6.9–13.0	—
Clopidogrel	32 (8.99)	6.4–12.4	—
Nicorandil	12 (3.37)	1.9–5.8	—
Non-cardiovascular drugs			
Alprazolam	62 (17.42)	13.8–21.7	—
Pantoprazole	48 (13.48)	10.3–17.4	—
Famotidine	36 (10.11)	7.4–13.7	—

Percentages are of all 356 patients; dose distributions are of users of each drug. ACE, angiotensin-converting enzyme; SR, sustained release. No patient received both loop diuretics or both an ACE inhibitor and an angiotensin receptor blocker.

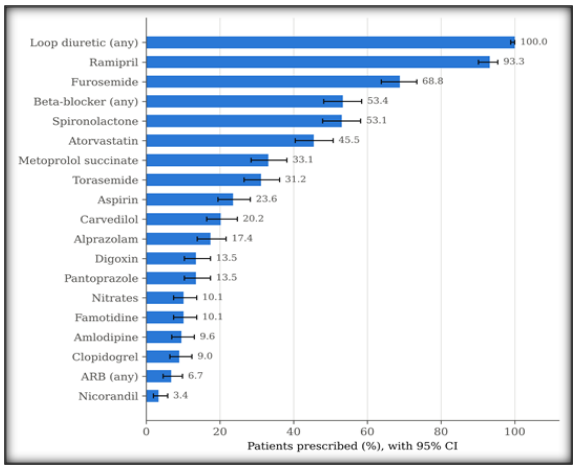

Figure 1: Proportion of patients prescribed each drug or drug class (n = 356). Bars show percentages; error bars show 95% confidence intervals (Wilson score). ARB, angiotensin receptor blocker.

Dose analysis: PDD/DDD ratio and DU90%: The PDD/DDD ratios are shown in Table 3 and Figure 2. Ramipril was prescribed at nearly twice its DDD (PDD 4.78 mg; ratio 1.91) and atorvastatin slightly above its DDD (ratio 1.11). Furosemide (0.99) and telmisartan (1.00) were prescribed at par with their DDDs. All other HF drugs were prescribed below their DDDs: torasemide (0.80), losartan (0.67), digoxin (0.50), spironolactone (0.44) and, most markedly, carvedilol (0.14) and metoprolol (0.13).

In terms of DDD volume, ramipril alone accounted for 48.9% of total DDDs (178.4 DDDs per 100 patients per day). The DU90% segment comprised five drugs: ramipril, furosemide, atorvastatin, torasemide and spironolactone (cumulative 94.8%; [Figure 3]). Beta-blockers, digoxin and ARBs together contributed only 5.2% of total DDD volume despite beta-blockers being prescribed to more than half of the patients.

Table 3: Prescribed daily dose versus WHO defined daily dose, consumption volume and DU90% segment

Drug (ATC code)	Users, n	Mean PDD (mg/day)	WHO DDD (mg)	PDD/DDD	DDDs/100 patients/day	Share of total DDDs (%)	Cum. share (%)
Ramipril (C09AA05)	332	4.78	2.5	1.91	178.4	48.9	48.9
Furosemide (C03CA01)	245	39.76	40	0.99	68.4	18.8	67.7
Atorvastatin (C10AA05)	162	22.22	20	1.11	50.6	13.9	81.6
Torasemide (C03CA04)	111	11.98	15	0.80	24.9	6.8	88.4
Spironolactone (C03DA01)	189	32.87	75	0.44	23.3	6.4	94.8
Digoxin (C01AA05)	48	0.125	0.25	0.50	6.7	1.8	96.6
Metoprolol (C07AB02)	118	20.02	150	0.13	4.4	1.2	97.9
Losartan (C09CA01)	18	33.33	50	0.67	3.4	0.9	98.8
Carvedilol (C07AG02)	72	5.12	37.5	0.14	2.8	0.8	99.5
Telmisartan (C09CA07)	6	40.00	40	1.00	1.7	0.5	100.0

ATC, Anatomical Therapeutic Chemical; DDD, defined daily dose (WHO),[8] PDD, prescribed daily dose (mean among users). Cumulative DDD volume ≥ 90% defines the DU90% segment.[9] Carvedilol doses recorded as 6.5 mg/day in the source data were analysed as 6.25 mg/day (available strength). Digoxin PDD 0.125 mg/day.

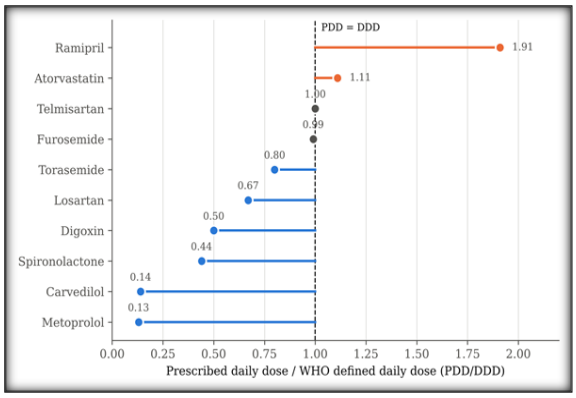

Figure 2: Ratio of prescribed daily dose (PDD) to WHO defined daily dose (DDD) for heart failure drugs. The dashed line marks PDD = DDD; orange points lie above and blue points below the DDD. Beta-blockers were prescribed at about one-eighth of their DDD.

Attainment of guideline target doses: Attainment of target doses is shown in Table 4 and Figure 4. Of ramipril users, 200 (60.2%) received at least 50% of the target dose (≥ 5 mg/day) and 42 (12.7%) received the full 10 mg/day. In contrast, no patient taking metoprolol or carvedilol received even 50% of the target dose; the highest prescribed doses were 12.5% of target for both agents. No losartan user reached 50% of the 150 mg target. Spironolactone was prescribed at ≥ 25 mg/day, the recommended maintenance dose, in 166 of 189 users (87.8%).

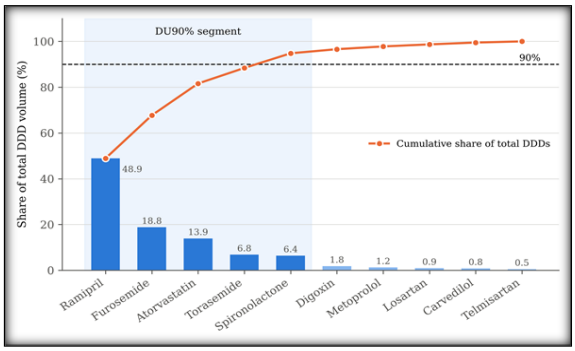

Figure 3: Drug utilisation 90% (DU90%) profile. Bars show each drug's share of total DDD volume; the line shows the cumulative share. Five drugs (shaded) account for 94.8% of DDD volume and form the DU90% segment.

Table 4: Attainment of guideline target doses among users of key heart failure drugs

Drug	Guideline target dose (mg/day)	Users, n	≥ 50% of target, n (%)	Target dose reached, n (%)	Highest dose prescribed (% of target)
Ramipril	10	332	200 (60.24)	42 (12.65)	20 mg (200%)
Losartan	150	18	0 (0)	0 (0)	50 mg (33%)
Metoprolol succinate	200	118	0 (0)	0 (0)	25 mg (12.5%)
Carvedilol	50	72	0 (0)	0 (0)	6.25 mg (12.5%)
Spironolactone	25 (up to 50)	189	189 (100)	166 (87.83)*	50 mg

*Users receiving ≥ 25 mg/day. Target doses from the 2009 ACC/AHA guideline.[10] Spironolactone: recommended maintenance dose 25 mg/day (up to 50 mg/day).

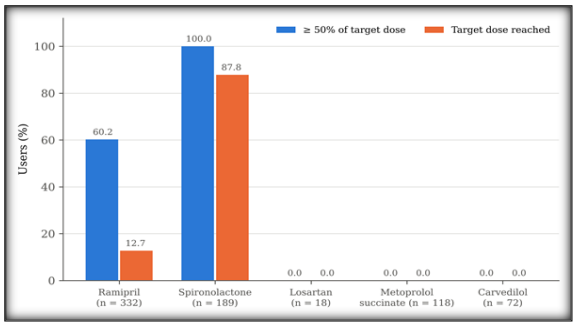

Figure 4: Attainment of guideline target doses among users of key heart failure drugs. Target doses: ramipril 10 mg, losartan 150 mg, metoprolol succinate 200 mg, carvedilol 50 mg and spironolactone 25 mg/day. No user of losartan, metoprolol or carvedilol reached 50% of the target dose.

WHO prescribing indicators and cost: The WHO core prescribing indicators are shown in [Table 5]. The average number of drugs per encounter was 4.39. Only 12.4% of drugs were prescribed by generic name and 50.0% were from the essential medicines list or hospital formulary. No encounter included an antibiotic or an injection. The mean daily drug cost per patient was INR 42.23 (range 21.15–73.40), corresponding to about INR 1267 per month, or approximately 11.5% of the mean monthly household income.

Table 5: WHO core prescribing indicators and cost of therapy (356 encounters)

WHO prescribing indicator	Observed value	WHO ideal / reference
Average number of drugs per encounter	4.39	As low as clinically appropriate†
Drugs prescribed by generic name (%)	12.37	100
Encounters with an antibiotic (%)	0	Lowest appropriate
Encounters with an injection (%)	0	Lowest appropriate
Drugs from essential medicines list / formulary (%)	50.00	100
Average drug cost per patient per day, INR (range)	42.23 (21.15–73.40)	—
Estimated monthly drug cost, INR (% of mean household income)	≈ 1267 (≈ 11.5%)	—

†Polypharmacy is expected in evidence-based heart failure treatment; the WHO general reference does not apply directly. Indicators as defined by the WHO.[7] INR, Indian rupee. Monthly cost estimated as daily cost × 30.

DISCUSSION

Key results: In this cohort of ambulatory patients with mild HF treated at a government teaching hospital in eastern India, the choice of drug classes largely followed the guidelines current at the time. All patients received a renin–angiotensin system blocker and a loop diuretic, and more than half received a beta-blocker and an aldosterone antagonist. Prescribing was rational in that no antibiotic or injection was used. However, three important gaps emerged: profound under-dosing of beta-blockers, low use of generic names and essential medicines, and a medication cost that was substantial relative to household income.

Patient profile: Our patients were relatively young (mean age 58 years), predominantly male and from low-income households, a profile consistent with Indian registries, in which HF presents about a decade earlier than in Western populations.[3,4] More than half came from rural areas, indicating that HF is no longer an urban disease in India. Comorbid smoking, diabetes and hypertension were common, in keeping with the epidemiological transition described for India.[2] The age and income profile may, however, partly reflect referral to a public institution rather than the wider population of patients with HF.

Renin–angiotensin system blockade: Universal use of an ACEI or ARB compares favourably with international outpatient registries; in CHAMP-HF, 27% of eligible patients with HFrEF did not receive ACEI, ARB or angiotensin receptor–neprilysin inhibitor therapy.[16] and in the global QUALIFY survey adherence to guideline-recommended medications varied considerably by region.[17] In the Indian National Heart Failure Registry, only about half of eligible patients received full GDMT at discharge.[4] The high PDD/DDD ratio of ramipril (1.91) should be interpreted in light of the low WHO DDD (2.5 mg), which is well below the HF target dose of 10 mg. Measured against the HF target, 60.2% of users received at least half of the target dose and 12.7% received the full dose. These proportions

are similar to those in QUALIFY, where 63.3% of ACEI users received at least half of the target dose and 27.9% received the full dose.[17]

The ATLAS trial showed that higher ACEI doses reduce the combined risk of death or hospitalisation compared with low doses.[11] so further up-titration of ramipril, blood pressure and renal function permitting, is warranted. Similarly, the HEAAL trial demonstrated that losartan 150 mg/day is superior to 50 mg/day.[15] in our cohort, no losartan user exceeded 50 mg/day. Ramipril was the only ACEI used. Although ramipril has strong outcome data, enalapril is equally evidence-based for HFrEF, is included in India's essential medicines list and is generally cheaper. Preferential use of enalapril could reduce treatment cost without compromising benefit. Switching to an ARB was appropriately reserved for patients with ACEI-induced cough.

Beta-blockers: Beta-blocker under-dosing was the most important gap. Although 53.4% of patients received a beta-blocker, the PDD/DDD ratios of 0.13 and 0.14 indicate that metoprolol and carvedilol were prescribed at roughly one-eighth of their DDDs, and no patient reached even half of the target dose. Because two-thirds of our patients had HFrEF, beta-blocker use itself was also below the level expected. The mortality reductions demonstrated with bisoprolol in CIBIS-II.[12] and with metoprolol succinate in MERIT-HF.[13] were achieved with structured up-titration to target or maximally tolerated doses. Under-dosing of beta-blockers is a recognised global problem; in CHAMP-HF only 28% of users received target doses.[16] and in QUALIFY 14.8% did so.[17] The near-complete absence of up-titration in our setting is more marked, however. Possible reasons include concern about hypotension and bradycardia, fear of worsening HF, limited time for follow-up in busy OPDs and the absence of nurse-led titration clinics. Because our study observed a single encounter, some patients may have been in an early titration phase; nevertheless, the uniformly low doses suggest a systematic rather than an individual pattern. Structured titration protocols and dedicated HF clinics are likely to have the greatest impact here.

Diuretics: All patients received a loop diuretic. Furosemide was prescribed at a PDD equal to its DDD (ratio 0.99), and torasemide below its DDD (0.80). Loop diuretics relieve congestion but have no proven mortality benefit, and guidelines recommend using the lowest dose that maintains euvolaemia [10,20]. Universal loop-diuretic use in patients in NYHA class I–II, many of whom may have been euvolaemic, may therefore represent continuation of therapy started during decompensation without subsequent review. The TRANSFORM-HF trial found no difference in mortality between torasemide and furosemide.[21] so the choice between agents can be guided by cost and availability.

Aldosterone antagonists and digoxin: Spironolactone was prescribed to 53.1% of patients, and most users received an appropriate maintenance dose of at least 25 mg/day. Although aldosterone antagonists have often been regarded as therapy for advanced HF only, this view is outdated: whereas the RALES trial established benefit in severe HFrEF.[14] the EMPHASIS-HF trial subsequently showed that eplerenone reduces cardiovascular death and HF hospitalisation in NYHA class II HFrEF.[22] and current guidelines recommend mineralocorticoid receptor antagonists for all symptomatic patients with HFrEF.[20,23] Spironolactone use in our cohort is therefore largely appropriate, provided that potassium and renal function are monitored. Its low PDD/DDD ratio (0.44) reflects the high WHO DDD (75 mg, based on its use as a diuretic), rather than under-dosing for HF. Eplerenone was not prescribed, probably because of cost. Digoxin was used sparingly (13.5%) at a conservative 0.125 mg/day, consistent with evidence that digoxin reduces hospitalisation without affecting mortality and that low serum concentrations are preferred.[24]

Statins, antiplatelet agents and other drugs: Atorvastatin was prescribed to 45.5% of patients and ranked third in DDD volume. Statins do not improve outcomes in HFrEF itself.[25] so this pattern most likely reflects treatment of coexisting coronary artery disease and dyslipidaemia, which are frequent causes of HF in India.[4] The use of aspirin, clopidogrel and nitrates likewise indicates an underlying ischaemic aetiology in a sizeable proportion of patients. Prescription of alprazolam (17.4%) and acid-suppressive drugs (23.6% combined) is notable. Gastroprotection is reasonable for patients receiving antiplatelet therapy, but routine benzodiazepine use lacks evidence in HF and carries risks of sedation and falls in older adults; anxiety and sleep disturbance in HF warrant specific assessment rather than empirical anxiolytic prescribing.

WHO prescribing indicators and cost: An average of 4.39 drugs per encounter is higher than the WHO-recommended level for general practice, but polypharmacy is inherent to evidence-based HF care, and this indicator should be interpreted in context. The complete absence of antibiotic and injection use is a strength. In contrast, only 12.4% of drugs were prescribed by generic name and 50% were from the essential medicines list, far below the WHO ideal of 100% for both.[7] Brand-name prescribing obliges patients to purchase more expensive branded products and reduces the opportunity to use subsidised hospital supplies. A daily cost of INR 42.23, equivalent to about one-ninth of household income, is a heavy burden for lifelong therapy and is likely to compromise adherence. As noted in DU90% analyses elsewhere, adherence to evidence-based guidelines does not automatically lower cost.[9] in our study, class-level guideline concordance coexisted with avoidable cost from branded prescribing. Generic prescribing and preferential use of essential medicines such as enalapril are practical, low-cost interventions.

Context of current guidelines: This study reflects prescribing in 2018, before angiotensin receptor–neprilysin inhibitors and sodium–glucose

cotransporter 2 inhibitors became part of GDMT.[20,23] These newer classes improve outcomes in HFrEF but are more expensive, so the affordability problems identified here are likely to be even greater today. The key message of this study, that drug-class selection alone is insufficient without dose optimisation and attention to cost, remains directly relevant to contemporary practice in India.

Limitations: This study has several limitations. First, it was conducted at a single centre and was restricted to the Cardiology OPD; many patients with NYHA class I–II HF are managed in general medicine clinics, and their prescribing may differ. Second, the single-encounter design did not allow assessment of dose titration over time, adherence, adverse drug reactions or clinical outcomes. Third, prescribing data were not stratified by LVEF category, so class-specific guideline adherence could not be assessed separately for HFrEF and HF with preserved or mildly reduced ejection fraction. Fourth, reasons for low doses (such as hypotension, bradycardia or renal impairment) were not systematically recorded. Fifth, 70 years were excluded, which limits generalisability to more severe or older patients. Finally, the data were collected in 2018, and practice may have changed since then.

Generalisability: The findings are likely to apply to government teaching hospitals in India that serve low- and middle-income populations and face similar resource constraints. They may not reflect private-sector practice, where patient income, drug availability and prescribing incentives differ.

CONCLUSION

In ambulatory patients with mild HF at a government tertiary care hospital in eastern India, drug-class selection was broadly concordant with contemporaneous ACC/AHA guidelines, with universal renin–angiotensin system blockade and no irrational use of antibiotics or injections. However, beta-blockers were markedly under-dosed, ACEIs and ARBs were rarely titrated to target, generic prescribing and use of essential medicines were low, and the cost of therapy was high relative to household income. Structured dose up-titration, dedicated HF clinics, generic prescribing and preferential use of essential medicines could substantially improve both the quality and the affordability of HF care. Multicentre studies with longitudinal follow-up of dose titration and outcomes are needed.

REFERENCES

1. Savarese G, Becher PM, Lund LH, Seferovic P, Rosano GMC, Coats AJS. Global burden of heart failure: a comprehensive and updated review of epidemiology. Cardiovasc Res. 2023;118(17):3272–87.
2. Huffman MD, Prabhakaran D. Heart failure: epidemiology and prevention in India. Natl Med J India. 2010;23(5):283–8.
3. Harikrishnan S, Sanjay G, Anees T, Viswanathan S, Vijayaraghavan G, Bahuleyan CG, et al. Clinical presentation, management, in-hospital and 90-day outcomes of heart failure patients in Trivandrum, Kerala, India: the Trivandrum Heart Failure Registry. Eur J Heart Fail. 2015;17(8):794–800.
4. Harikrishnan S, Bahl A, Roy A, Mishra A, Prajapati J, Manjunath CN, et al. Clinical profile and 90 day outcomes of 10 851 heart failure patients across India: National Heart Failure Registry. ESC Heart Fail. 2022;9(6):3898–908.
5. Dokainish H, Teo K, Zhu J, Roy A, AlHabib KF, ElSayed A, et al. Global mortality variations in patients with heart failure: results from the International Congestive Heart Failure (INTER-CHF) prospective cohort study. Lancet Glob Health. 2017;5(7):e665–72.
6. WHO International Working Group for Drug Statistics Methodology, WHO Collaborating Centre for Drug Statistics Methodology, WHO Collaborating Centre for Drug Utilization Research and Clinical Pharmacological Services. Introduction to drug utilization research. Geneva: World Health Organization; 2003.
7. World Health Organization. How to investigate drug use in health facilities: selected drug use indicators. WHO/DAP/93.1. Geneva: World Health Organization; 1993.
8. WHO Collaborating Centre for Drug Statistics Methodology. Guidelines for ATC classification and DDD assignment 2013. Oslo: Norwegian Institute of Public Health; 2012.
9. Bergman U, Popa C, Tomson Y, Wettermark B, Einarson TR, Aberg H, et al. Drug utilization 90%—a simple method for assessing the quality of drug prescribing. Eur J Clin Pharmacol. 1998;54(2):113–8.
10. Hunt SA, Abraham WT, Chin MH, Feldman AM, Francis GS, Ganiats TG, et al. 2009 focused update incorporated into the ACC/AHA 2005 guidelines for the diagnosis and management of heart failure in adults. Circulation. 2009;119(14):e391–479.
11. Packer M, Poole-Wilson PA, Armstrong PW, Cleland JG, Horowitz JD, Massie BM, et al. Comparative effects of low and high doses of the angiotensin-converting enzyme inhibitor, lisinopril, on morbidity and mortality in chronic heart failure. ATLAS Study Group. Circulation. 1999;100(23):2312–8.
12. CIBIS-II Investigators and Committees. The Cardiac Insufficiency Bisoprolol Study II (CIBIS-II): a randomised trial. Lancet. 1999;353(9146):9–13.
13. MERIT-HF Study Group. Effect of metoprolol CR/XL in chronic heart failure: Metoprolol CR/XL Randomised Intervention Trial in Congestive Heart Failure (MERIT-HF). Lancet. 1999;353(9169):2001–7.
14. Pitt B, Zannad F, Remme WJ, Cody R, Castaigne A, Perez A, et al. The effect of spironolactone on morbidity and mortality in patients with severe heart failure. N Engl J Med. 1999;341(10):709–17.
15. Konstam MA, Neaton JD, Dickstein K, Drexler H, Komajda M, Martinez FA, et al. Effects of high-dose versus low-dose losartan on clinical outcomes in patients with heart failure (HEAAL study): a randomised, double-blind trial. Lancet. 2009;374(9704):1840–8.
16. Greene SJ, Butler J, Albert NM, DeVore AD, Sharma PP, Duffy CI, et al. Medical therapy for heart failure with reduced ejection fraction: the CHAMP-HF registry. J Am Coll Cardiol. 2018;72(4):351–66.
17. Komajda M, Anker SD, Cowie MR, Filippatos GS, Mengelle B, Ponikowski P, et al. Physicians' adherence to guideline-recommended medications in heart failure with reduced ejection fraction: data from the QUALIFY global survey. Eur J Heart Fail. 2016;18(5):514–22.
18. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet. 2007;370(9596):1453–7.
19. McKee PA, Castelli WP, McNamara PM, Kannel WB. The natural history of congestive heart failure: the Framingham study. N Engl J Med. 1971;285(26):1441–6.
20. Heidenreich PA, Bozkurt B, Aguilar D, Allen LA, Byun JJ, Colvin MM, et al. 2022 AHA/ACC/HFSA guideline for the management of heart failure. Circulation. 2022;145(18):e895–1032.

21. Mentz RJ, Anstrom KJ, Eisenstein EL, Sapp S, Greene SJ, Morgan S, et al. Effect of torsemide vs furosemide after discharge on all-cause mortality in patients hospitalized with heart failure: the TRANSFORM-HF randomized clinical trial. JAMA. 2023;329(3):214–23.
22. Zannad F, McMurray JJ, Krum H, van Veldhuisen DJ, Swedberg K, Shi H, et al. Eplerenone in patients with systolic heart failure and mild symptoms. N Engl J Med. 2011;364(1):11–21.
23. McDonagh TA, Metra M, Adamo M, Gardner RS, Baumbach A, Böhm M, et al. 2021 ESC guidelines for the diagnosis and treatment of acute and chronic heart failure. Eur Heart J. 2021;42(36):3599–726.
24. Digitalis Investigation Group. The effect of digoxin on mortality and morbidity in patients with heart failure. N Engl J Med. 1997;336(8):525–33.
25. Kjekshus J, Apetrei E, Barrios V, Böhm M, Cleland JG, Cornel JH, et al. Rosuvastatin in older patients with systolic heart failure. N Engl J Med. 2007;357(22):2248–61.