

Cost-Effectiveness Analysis of Multidisciplinary Care in Chronic Heart Failure: Insights from an Indonesian Tertiary Hospital

Lusiani^{1,3,4,5*}, Nurhayati Adnan Prihartono¹, Mardiaty Nadjib², Idrus Alwi^{3,4,5}

¹Department of Epidemiology, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia.

²Department of Health Policy and Administration, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia.

³Cardiology Division, Internal Medicine Department, Faculty of Medicine, Universitas Indonesia.

⁴Adult Cardiovascular Division, Cardiovascular Department, Cipto Mangunkusumo Hospital, Jakarta, Indonesia.

⁵Integrated Cardiocerebrovascular Services of Cipto Mangunkusumo Hospital, Jakarta, Indonesia.

*Corresponding Author:

Lusiani, MD., PhD. Department of Epidemiology, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia.

Email: Lusianirusdi@gmail.com

ABSTRACT

Background: Chronic heart failure (CHF) is the leading cause of morbidity and healthcare expenditure in Indonesia, largely due to recurrent hospitalizations. Multidisciplinary Programs (MDSs) have been introduced to provide clinical and economic advantages by reducing hospitalizations. This study aimed to compare direct medical cost trajectories between patients managed under MDP and standard care (SC) at a tertiary referral hospital. **Methods:** The retrospective cohort study was conducted at Dr. Cipto Mangunkusumo National Hospital and included 189 patients with CHF who completed at least eight consecutive outpatient visits. Patient demographics, clinical data, and direct medical costs were obtained from medical records and hospital billing data. **Results:** Patients in the MDP group were younger (median age 55 vs 60 years) and had a more frequent ischemic etiology compared with SC. Outpatient costs were higher in MDP, mainly due to medications and consultation fees, while inpatient costs were substantially lower, particularly for procedures, consumables, and ward charges. The total direct medical cost per patient was significantly lower in MDP compared with SC (Rp 19.4 million vs Rp 31.3 million), reflecting a 38% reduction. **Conclusion:** Implementation of an MDP reduced overall direct medical costs by shifting expenditures toward outpatient management and lowering costly inpatient utilization. These findings support MDP as a feasible and cost-efficient strategy in resource-limited health systems.

Keywords: Cost-benefit analysis, heart failure, patient care team, tertiary care centers, Indonesia, quality-adjusted life years.

INTRODUCTION

Heart failure (HF) remains a leading cause of morbidity and health expenditure worldwide, primarily due to recurrent decompensations that frequently result in hospital readmissions. The prevalence of Chronic Heart Failure (CHF) in Indonesia is estimated at >5%, exceeding the mean prevalence of CHF in Asia and

Europe (1-3%).¹ Recent data estimated the Age-Standardized Prevalence Rate of CHF in 2019 ranged from 900.90 (717.73-1,138.87) per 100.000 population.² Despite the advent of pharmaceutical options, CHF has become one of the major challenges for the Indonesian Health System, particularly due to its high rates of rehospitalization, frequent outpatient visits,

and still associated with substantial mortality.^{3,4} Previous hospital-based studies in Indonesia have reported that the 30-day readmission rate of patients with chronic heart failure remains high, ranging from approximately 25% to 30%.⁵ Rehospitalization accounts for approximately 65% of the total medical expenses associated with CHF.⁶⁻⁸ Notably, there is a cost difference of approximately USD 3,773 between patients with and without 30-day readmission.⁹ In Malaysia, a recent multi-centre cost analysis reported that inpatient care accounted for nearly 75% of the annual heart failure costs.¹⁰ Resource constraints exacerbate this issue, necessitating highly efficient and effective management strategies.

Multidisciplinary programs (MDPs) have emerged as a promising approach, involving various healthcare professionals to provide comprehensive, coordinated care aimed at improving patient adherence, optimizing guideline-directed medical therapy (GDMT), and fostering self-management.¹¹ In contrast to standard care, MDP emphasized optimization of interprofessional collaboration between cardiologists, nurses, pharmacists, physiotherapists, and nutritionists. Several studies have proven the effectiveness of MDP to reduce 30-day hospitalization and mortality of CHF patients.¹² A current meta-analysis concluded that MDP for CHF patients was associated with a reduction in all-cause mortality at 12 months by 36%.¹³

While MDPs have demonstrated clinical benefits, including reduced readmissions, for CHF patients, there remains a notable gap in detailed comparative cost analysis, especially concerning cost trajectories. Research about cost trajectories of MDP may vary, depending on provider, country, and the characteristics of patients. In Indonesia, Dr Cipto Mangkunkusumo National Hospital (RSCM) established the first heart failure clinic, which applied multidisciplinary principles in 2018.¹⁴ Addressing this gap is crucial to guide policy, improve resource allocation, and support heart failure strategies. This study aims to compare the direct medical costs attributable to heart failure readmissions between patients

managed under the MDP and those receiving standard care (SC) at a tertiary hospital in Indonesia.

METHODS

This retrospective cohort study used medical record data from the Information Technology System Management Unit (ITSMU) - RSCM. Patients eligible for this study were adults aged 18 years or older with a confirmed diagnosis of CHF based on the 2021 ESC or 2022 ACC diagnostic criteria, who had been recently hospitalized for acute decompensated heart failure and subsequently attended their first outpatient follow-up at RSCM. Patients were excluded if they had fewer than eight consecutive months of outpatient visits, died or were lost to follow-up during the observation period, had incomplete medical records, or presented with other major life-limiting comorbidities unrelated to CHF that could significantly confound healthcare utilization and costs.

Data were collected for two distinct cohorts of CHF patients; those receiving standard care (SC) (2017-2018) and those enrolled in MDP (2022-2023).

Patients enrolled in MDP received a structured and team-based care program following a standardized clinical pathway (**Figure 1**). The program consisted of 8 structured outpatient visits over 25 weeks. Each visit included a standardized assessment with nursing education, pharmacy review, nutritional counseling, and supervised cardiac rehabilitation, alongside laboratory and imaging assessments as indicated. Patients also received guideline-directed medical therapy optimization, vaccination, and psychosocial support, with referrals for device therapy when appropriate. The pathway aimed to provide standardized, integrated care to reduce readmissions, improve functional status, and prepare patients for long-term maintenance in general outpatient follow-up (**Figure 1**). The SC group consisted of CHF patients followed at the same institution but managed through routine cardiology outpatient services without integrated multidisciplinary involvement.

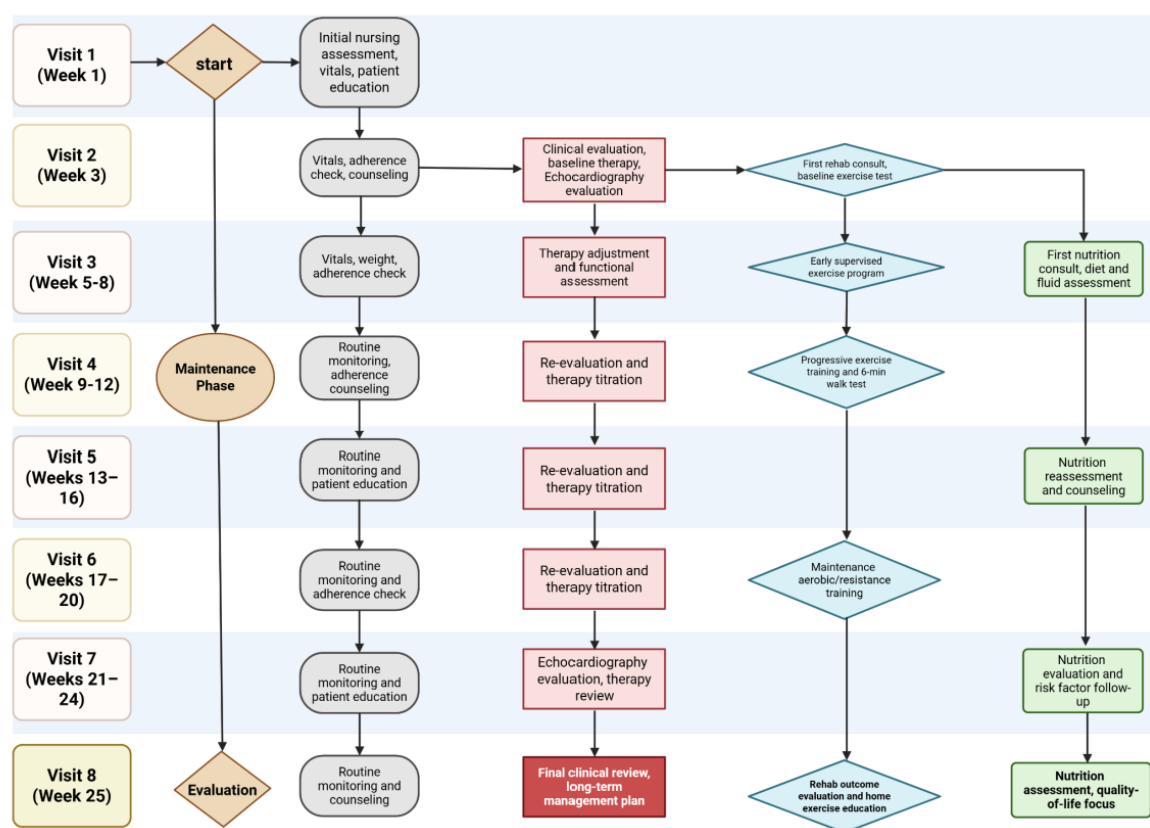


Figure 1. Clinical pathway of the multidisciplinary program for chronic heart failure at Dr. Cipto Mangunkusumo National Hospital

Univariate analyses were performed to describe baseline clinical and cost characteristics in both groups. Categorical data were summarized using absolute frequencies and percent values. Meanwhile, continuous data were reported using mean and standard deviation (SD), unless otherwise specified.

The study evaluated both clinical and economic effectiveness of the MDP compared to the SC group. Hazard cumulative of first readmission was calculated and compared between MDP and SC groups using Nelson-Aalen estimates and log-rank tests. Clinical effectiveness was assessed through logistic regression between cumulative hospital readmission and one-year mortality, followed by Receiver Operating Characteristic (ROC) curve analysis to identify the optimal cut-off of readmissions predicting mortality. Collinearity among predictors was evaluated using correlation matrices and variance inflation factors (VIF), with VIF >5 indicating multicollinearity.

Program effectiveness was estimated using

a Generalized Linear model (GLM) with a binomial distribution and identity link function to directly estimate the absolute risk difference (RD) between the MDP and SC. Cofounder screening was conducted using forward selection; variables that change the MDP coefficient by ≥ 10 were retained. Adjusted marginal and 95% confidence intervals were derived to compare program effectiveness. All statistical analyses were performed using STATA version 16.0 (StataCorp LLC, College Station, TX, USA).

The analysis was conducted from the hospital perspective, encompassing all direct medical cost records. Cost data were directly obtained from the hospital billing and financial database, capturing all inpatient and outpatient medical components. Direct medical costs included registration, physician consultations, nursing services, diagnosis services, laboratory investigations (hematologic, biochemistry), diagnostic investigations (electrocardiography, echocardiography, treadmill test, CMR, as indicated), pharmacological therapy, device

therapy where applicable, inpatient-related products occurring within follow-up, cardiac rehabilitation services, nutritional counseling, and vaccination services. Cost-saving was determined using the relative difference in mean total cost between MDP and SC, while robustness of findings was tested through one-way sensitivity analysis by varying major cost components by $\pm 25\%$, presented in a Tornado diagram. Outpatient expenditures were aggregated at each monthly visit and analyzed longitudinally over the eight-month observation period to compare cost trajectories between the multidisciplinary program and standard care groups. All costs were calculated in Indonesian Rupiah (Rp). The study protocol was reviewed and approved by the Medical Ethics Committee

of RSCM (Approval No. KET-499/UN2.F1/ETIK/PPM 00.02/2025).

RESULTS

A total of 260 patients with CHF (ICD I50) met the inclusion criteria. Of these, 71 patients were excluded due to fewer than eight consecutive outpatient visits ($n=12$), death or loss to follow-up ($n=18$), or incomplete medical records ($n=57$). A total of 189 patients with CHF were included in this study, consisting of 98 patients in the MDP group and 91 patients in the SC group (**Table 1**). The median age was younger in the MDP group compared with the SC group. Most patients were male (66.3% in MDP vs 70.3% in SC).

Table 1. Baseline Characteristics of Patients.

Characteristics	MDP (n=98)	SC (n=91)
Age (years)	55 (IQR 12)	60 (IQR 12)
Male n (%)	65 (66.3)	64 (70.3)
Etiology, n (%)		
• Ischemic	73 (74.5)	77 (84.6)
• Non-ischemic	25 (25.5)	14 (15.4)
• Valvular heart disease	11	4
• Hypertensive heart disease	1	5
• Arrhythmia	4	1
• Atrial septal defect	3	1
• Diabetes mellitus	2	1
• Systemic lupus erythematosus	1	1
• Thyroid heart disease	2	0
• Ventricular septal defect	0	1
• HIV	1	0
Charlson Comorbidity Index, n (%)		
• 1	22 (22.4)	12 (13.2)
• 2	40 (40.8)	26 (28.5)
• 3	16 (16.3)	38 (41.7)
• 4	13 (13.2)	11 (12.1)
• 5	2 (2.0)	4 (4.4)
• 6	3 (3.0)	0 (0)
• 9	2 (2.0)	0 (0)
Comorbidities, n (%)		
• Hypertension	39 (39.8)	58 (63.7)
• DM	42 (42.8)	47 (51.6)
• CKD 1-3	30 (30.6)	27 (29.6)
• CKD 4-5	5 (5.1)	7 (7.7)
• Dyslipidemia	24 (24.5)	21 (23.1)
• Arrhythmia	20 (20.4)	15 (16.5)
• COPD	3 (3.0)	5 (5.5)
• Stroke	3 (3.0)	5 (5.5)
• HIV	3 (3.0)	0 (0)
• SLE	1 (1.0)	0 (0)
BMI, kg/m ² (median, IQR)	25.2 (IQR 6.6)	25.6 (IQR 5.9)
LVEF, % (median, IQR)	39 (IQR 21.7)	36.3 (24.7)
• EF ≤ 40 , n (%)	62 (63.4)	49 (53.8)
• EF 41-49, n (%)	8 (8.1)	18 (19.8)
• EF ≥ 50 , n (%)	28 (28.5)	24 (26.4)

ARNI, n (%)	32 (32.6)	0 (0)
Device Therapy, n (%)	4 (4.1)	9 (9.9)
Cumulative Readmission, n (%)		
• 0 times	86 (87.8)	60 (65.9)
• 1 time	10 (10.2)	19 (20.8)
• 2 times	2 (2.2)	7 (7.7)
• 3 times	0 (0)	4 (4.4)
• 4 times	0 (0)	1 (1.1)
Length of Stay (Days)	5 (IQR 6)	7 (IQR 6)

ARNI = Angiotensin Receptor–Neprilysin Inhibitor; BMI = Body Mass Index; CKD = Chronic Kidney Disease; COPD = Chronic Obstructive Pulmonary Disease; DM = Diabetes Mellitus; EF = Ejection Fraction; HIV=Human Immunodeficiency Virus; LVEF = Left Ventricular Ejection Fraction; MDP = Multidisciplinary Program; NYHA = New York Heart Association; SC = Standard Care; SLE = Systemic Lupus Erythematosus

Ischemic heart disease was the predominant etiology in both groups. Non-ischemic causes included valvular heart disease, hypertensive heart disease, arrhythmias, atrial and ventricular septal defects, systemic lupus erythematosus, thyroid-related heart disease, diabetes mellitus–related cardiomyopathy, and HIV infection, collectively representing 25.5% in MDP and 15.4% in SC. Hypertension and diabetes mellitus were the most frequent comorbidities in both groups, followed by chronic kidney disease, dyslipidemia, and arrhythmias. Median body mass index was similar (25.5 kg/m² in MDP vs 25.6 kg/m² in SC), and both were classified as obese for the Asia-Pacific population.

Most patients were classified as NYHA functional class II. Median left ventricular ejection fraction (LVEF) was 39% (IQR 21.7) in the MDP group and 36.3% (IQR 24.7%) in the SC group, with HFrEF comprising 63.3%

and 53.8% of patients, respectively. Angiotensin receptor-neprilysin inhibitor (ARNI) therapy was prescribed in 32.7% of MDP patients and none in SC, while device therapy was more frequent in SC.

Clinical Effectiveness of MDP

The MDP group effectively lowered the proportion of readmission, with 87.8% of patients remaining free from readmission compared with 65.9% in the SC group. The median length of stay during the index hospitalization was 8 days (IQR 5) in MDP and 8 days (IQR 5) in SC.

The Nelson-Aalen curve (**Figure 2**) shows a cumulative hazard of first readmission between groups, with the SC group exhibiting an earlier and steeper rise in cumulative hazard. By 8 months, the cumulative hazard in SC (0.4) was higher than in MDP (0.10). The log-rank test confirmed a significant difference ($p<0.001$).

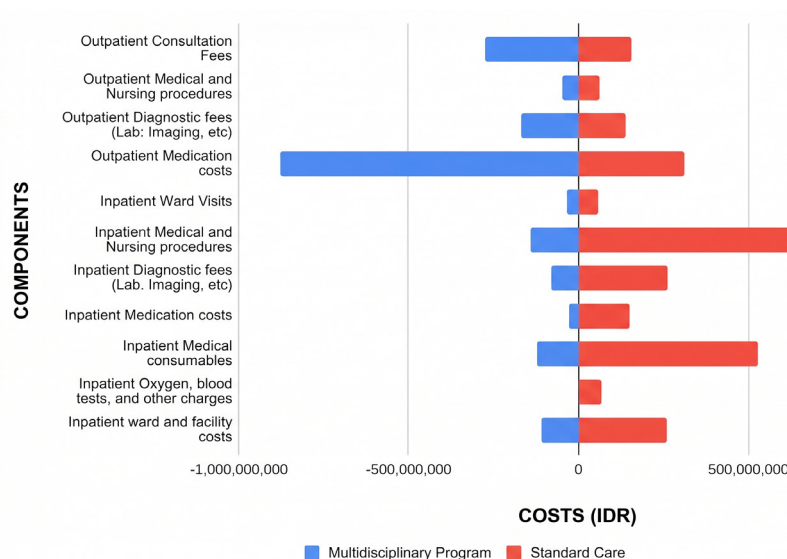


Figure 2. Nelson-Aalen Cumulative Hazard Curve of First Readmission in Both Groups.

Logistic regression analysis confirmed that cumulative hospital readmissions were independently associated with increased one-year mortality (OR = 2.06, 95% CI 1.25–3.40). Further ROC curve analysis demonstrated that the cumulative number of readmissions had a fair discriminative ability to predict mortality (AUC = 0.73) (**Figure 3**). Sensitivity analysis revealed optimal clinical cut-off was identified at ≥ 1 readmission, yielding the trade-off between sensitivity (66.7%) and specificity (81.9%) with a positive likelihood ratio (LR+ = 3.68) (**Supp. 1**). Patients with no readmission were therefore classified as clinically effective responders, comprising 87.8% of the MDP and 65.9% of the SC group (**Table 2**).

Collinearity diagnostics showed no multicollinearity (**Supp. 2**). In unadjusted linear analysis, MDP was significantly associated with achieving clinical effectiveness ($\beta = 0.243$; 95% CI 0.102–0.385). In the full GLM (identity link including all covariates), MDP retained a significantly higher absolute effect (RD = 0.310; 95% CI 0.156–0.465). Confounder screening using forward GLM identified NYHA class and ARNI use as influential variables (**Supp. 3**). After adjustment, MDP independently associated with an increased absolute risk difference of program effectiveness by 22.8% to SC (RD = 0.228; 95% CI 0.099–0.356). Estimated program effectiveness was 0.882 (95% CI 0.814–0.950) for MDP and 0.654 (95% CI 0.552–0.756) for SC.

Table 2. Proportion of Program Effectiveness between MDP and SC

Program	Effective	Not Effective	Total
MDP	86 (87.76%)	12 (12.24%)	98 (100%)
SC	60 (65.93%)	31 (34.07%)	91 (100%)
Total	146 (77.25%)	43 (22.75%)	189 (100%)

MDP multidisciplinary program; SC = Standard care; Percentages calculated by row.
Effective: cumulative readmission = 0 during the 8-month follow-up; Not effective: cumulative readmission ≥ 1 during the 8-month follow-up

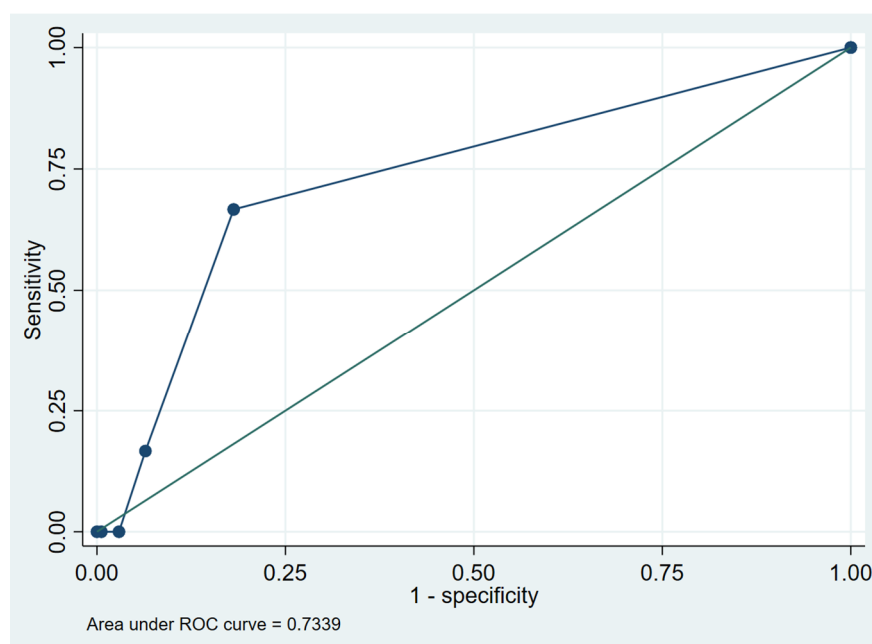


Figure 3. ROC curve

Cost Analysis of MDP

Figure 4 and Table 3 show that outpatient costs were consistently higher in the MDP, particularly for medications (IDR 879 million vs IDR 315 million) and consultation fees (IDR 276 million vs IDR 157 million). In contrast, inpatient expenditures were markedly lower in the MDP group, with the largest savings observed in medical and nursing procedures, medical consumables, and ward facility costs. These reductions resulted in lower total direct medical costs in the MDP group (IDR 1.9 billion vs IDR 2.85 billion).

Further analysis (Table 4) confirms these findings on a per-patient basis, with outpatient cost higher in MDP (IDR 14.0 million vs IDR 7.6 million) but inpatient cost markedly reduced (IDR 5.3 million vs IDR 23.8 million). Major cost drivers were medical and nursing procedures, diagnostic fees, and medical consumables. The mean total direct medical cost per patient was IDR 19.4 million in MDP versus IDR 31.3 million in SC, resulting in a 38.1% (IDR 11.9 million) cost saving over eight months per patient. Overall, MDP achieved superior outcomes with significant cost savings.

Table 3. Direct medical costs of outpatient and inpatient care in MDP versus standard care

Component	MDP (IDR)	SC (IDR)
Outpatient Costs		
Consultation Fees	276,759,000	157,975,000
Medical and Nursing procedures	49,284,748	65,879,000
Diagnostic fees (Lab, Imaging, etc.)	169,410,500	138,456,241
Medication costs	879,794,216	315,471,854
Medical consumables	798,617	11,710,367
Total Outpatient Costs	1,376,047,081	689,492,462
Inpatient Costs		
Ward Visits	34,010,000	56,868,000
Consultation Fees	2,779,000	14,746,000
Medical and Nursing procedures	141,980,379	816,538,358
Diagnostic fees (Lab, Imaging, etc.)	81,913,000	264,608,764
Medication costs	27,538,521	150,672,075
Medical consumables	124,272,242	529,444,739
Oxygen, blood tests, and other charges	2,241,000	68,920,000
Inpatient ward and facility costs	109,437,000	261,131,000
Total Inpatient Costs	524,171,142	2,162,928,936
Total Direct Medical Costs	1,900,218,223	2,852,421,398

MDP= Multidisciplinary Program; SC= Standard Care

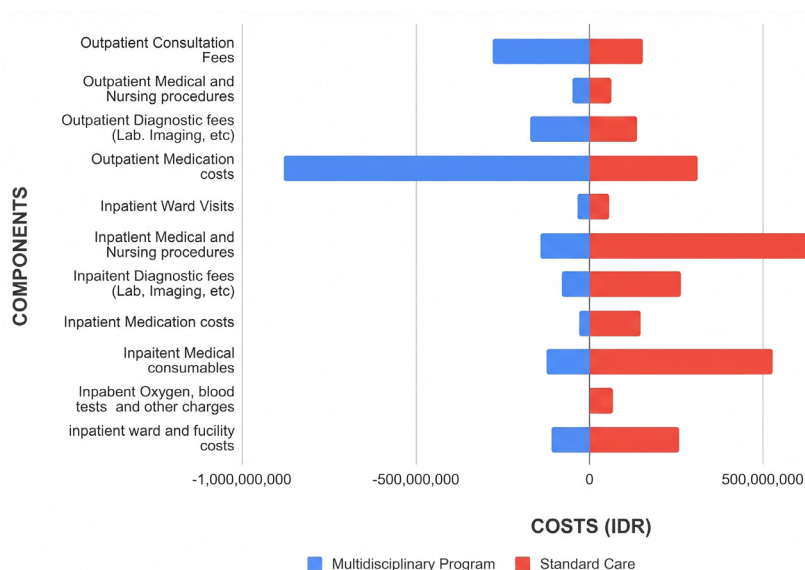


Figure 4. Direct medical costs by component in the multidisciplinary program and standard care

Table 4. Direct medical costs per patient in the MDP and SC

Component	MDP (IDR)	SC (IDR)	Difference	
			Δ (IDR)	Δ (%)
Outpatient Costs				
Consultation Fees	2,824,071	1,735,989	-1.088.082	-62.6
Medical and Nursing procedures	502,906	723,945	+221.039	+30.5
Diagnostic fees (Lab, Imaging, etc)	1,728,679	1,521,497	-207.182	-13.6
Medication costs	8,977,492	3,466,724	-5.510.768	-158.9
Medical consumables	8,149	128,685	+120.536	+93.6
Total Outpatient Cost	14,041,297	7,576,840	-6.464.457	-85.3
Inpatient Costs				
Ward Visits	347,041	624,923	+277,882	+44.4
Consultation Fees	28,357	162,044	+133,687	+82.5
Medical and Nursing procedures	1,448,779	8,972,929	+7.524.170	+83.8
Diagnostic fees (Lab, Imaging, etc.)	835,847	2,907,789	+2.071.942	+71.2
Medication costs	281,005	1,655,737	+1.374.732	+83.0
Medical consumables	1,268,084	5,818,074	+4.549.990	+78.2
Oxygen, blood tests, and other charges	22,867	757,363	+734.496	+96.9
Inpatient ward and facility costs	1,116,704	2,869,571	+1.752.867	+61.0
Total Inpatient Costs	5,348,685	23,768,450	+18419765	+77.4
Total Direct Medical Costs	19,389,982	31,345,290	+11,955,308	38.1

MDP= Multidisciplinary Program; SC= Standard Care

As shown in **Table 5**, the mean direct medical cost per admission was IDR 37.44 million in the MDP group versus IDR 44.44 million in SC, reflecting 15% lower inpatient cost under MDP care. Although the average length of stay was similar (8.1 days), the average cost per hospital day was markedly lower in MDP (IDR 3.98 million/day) than in SC (IDR 5.97 million per

day), resulting in IDR 1.9 million cost savings per day of readmission. The intensive/emergency unit contributed the largest cost component, yet MDP consistently maintained lower per-day expenses, indicating greater cost efficiency per hospitalization day through improved stability and reduced high-cost care utilization.

Table 5. Direct Medical Cost per Hospital Day of Readmission

Program / Ward Class	Mean Cost (IDR)	Mean Length of Stay (days)	Mean Cost per Hospital Day (IDR/day)
MDP	37,440,796	8.1 (2–22)	3,979,328
Intensive / Emergency Ward	24,510,219	5.8 (2–8)	3,570,196
VIP Class	—	—	—
Class I	88,278,030	13.5 (5–22)	4,749,340
Class II	6,024,167	4 (4–4)	1,506,042
Class III	34,792,863	8.6 (4–13)	4,346,441
SC	44,141,407	8.1 (2–33)	5,970,099
Intensive / Emergency Ward	79,139,361	4.3 (2–6)	28,774,917
VIP Class	72,387,218	21 (21–21)	3,447,010
Class I	91,303,548	18.3 (3–33)	7,002,416
Class II	7,691,928	3.5 (3–4)	2,266,288
Class III	24,331,013	7.6 (2–13)	2,981,581

MDP= Multidisciplinary Program; SC= Standard Care

One-way sensitivity analyses were conducted to test the robustness of the model's parameter uncertainty. Program effectiveness was varied across the 95%CI, and costs were varied by $\pm 20\%$. After varying effectiveness and costs, the model remained cost-saving and robust. The primary cost driver was outpatient medication costs.

DISCUSSION

Heart Failure Clinic at RSCM represents the first structured MDP clinical pathway for CHF in Indonesia, integrating cardiology, nursery, pharmacology, nutrition, and rehabilitation services into coordinated outpatient care. The program was designed to redistribute healthcare utilisation by front-loading resources into structured outpatient visits, education, and rehabilitation, in order to prevent clinical deterioration and reduce costly hospitalization.^{15,16} Previous implementations around the world have demonstrated reduced rates of readmission among CHF patients receiving a multidisciplinary approach.¹⁷⁻¹⁹ More recently, studies of MDP and nurse-led programs have confirmed that such approaches not only enhance GDMPT optimization but also improve patient knowledge, self-care, and cost.²⁰

The characteristics of the study population largely reflected the typical CHF demographic in Indonesia, with the majority being male, ischemic etiology, and classified as HFrEF. Unlike many previous MDP studies, the population here is relatively younger, with an age range of 50-60 years.^{21,22} With the increasing prevalence of hypertension and diabetes mellitus, CHF patients in Indonesia are characterized by younger onset and multiple comorbidities.^{2,5} The wide variety of non-ischemic CHF etiologies reflects the capabilities of tertiary centers treating complex cases. Nonetheless, the consistency of heart failure etiology, comorbidities, NYHA functional class, and LVEF distribution across groups underscores the comparability of cohorts and strengthens the internal validity of our cost comparisons.

Differences in ARNI and device therapy allocation between groups were driven by variations in clinical practice standards, drug

availability, and access across the treatment period. In the 2017-2018 SC group, ARNI and device therapy were not yet routinely available, reimbursed, or incorporated into treatment protocols. By contrast, in the 2022-2023 MDP cohort, both ARNI and device therapy had become accessible within the RSCM heart failure clinical pathway, though device implantation continued to follow strict clinical indications.

In this study, MDP participation was clinically effective in reducing hospital readmissions and improving overall patient stability among individuals with CHF. These findings are consistent with previous evidence showing the benefit of coordinated, team-based disease management approaches. A randomized trial study from Australia revealed that structured disease management intervention reduces short-term readmission risks at both 30 and 90 days.²³ Similar outcomes have been observed in cohorts from China with systolic heart failure.²⁴ ROC curve analysis confirmed that cumulative readmission was a significant predictor of one-year mortality, identifying more than one readmission as the optimal threshold for clinical deterioration. Data from European and Russian Cohorts showed that frequent hospitalizations were strongly associated with higher mortality and poorer cardiac recovery.^{25,26} Specifically, North American registry data identified the first 30 to 90 days post-discharge as the most vulnerable period for relapse.²⁷ Cumulative hazard analysis showed that MDP patients had a lower and delayed risk of first readmission. The multivariable GLM adjustment confirmed that the effectiveness differences were not confounded by disease severity or advanced therapy use.

The total direct medical cost per patient in our study was relatively lower compared with reports from other MDP studies.^{8,10,28} In Singapore, the average outpatient cost per patient visit ranged between ~IDR 24-61 million per patient. This difference likely reflects greater GDMT optimization abroad, including wider usage of ARNI and SGLT2 inhibitors, which remains limited in Indonesia.⁸ In Addition, a TDABC-based study conducted in a regional Hospital in Indonesia reported an average inpatient cost

per patient of IDR 2.18 million, which was comparable to the INA-CBGs reimbursement rate (IDR 2.43 million).²⁹ In contrast, the total cost per patient in Portugal was lower (IDR 20.7 million), which may be explained by differences in health system financing and cost structures.³⁰

Cost analysis highlights a clear redistribution of healthcare expenditures between the MDP and SC group. While the MDP group demonstrated higher outpatient costs, mainly from medications, consultation, and structured rehabilitation, they were substantially offset by lower inpatient expenditures. This redistribution highlights the mechanism by which MDP achieves overall cost savings: front-loading investment into outpatient care serves as a protective measure, preventing decompensation and avoiding costly hospitalizations.^{31,32} In Singapore, savings have been attributed to fewer unplanned readmissions and improved outpatient medication adherence.^{8,33} A multi-center analysis from Malaysia showed that inpatient admission and procedures were the main cost drivers in CHF management and account for 75% of its expenditure.¹⁰

Evidence from European countries has consistently shown that team-based approaches reduce healthcare costs across diverse healthcare systems.³⁴⁻³⁶ These programs demonstrate a consistent economic pattern: higher upfront outpatient expenditures and a substantial reduction in patients' utilisation, particularly fewer emergency admissions. Cost savings were mainly driven by fewer inpatient admissions and ER visits.^{37,38} Specifically, MDP manages to reduce inpatient care costs by reducing the length of stay and decreasing the use of invasive procedures.³⁹

More recent investigations have shown that nurse-led multidisciplinary clinics not only optimise GDMT use but also achieve significant cost savings by lowering hospitalisation burden.⁴⁰ In Singapore, multidisciplinary disease management programs redistribute healthcare costs, shifting resources toward planned outpatient care while lowering unplanned inpatient spending.²⁰ A Thai cost-utility study showed multidisciplinary care reduced hospitalization costs, achieving overall savings despite higher outpatient expenses.⁴¹

This study represents a comparative cost trajectory analysis of MDP versus standard care in a southeast asian tertiary referral setting, offering valuable insights for health policy and resource allocation. The analysis was based on comprehensive hospital billing data, capturing all direct medical cost components. Furthermore, the use of a structured clinical pathway at CMH provides a reproducible model that can be scaled to other tertiary and secondary hospitals in Indonesia.

Several potential limitations should be acknowledged. This study is limited by its retrospective design and restriction to a single tertiary hospital. Selection bias may have occurred since patients with incomplete medical records, loss-to-follow-up, or death within the observation period were excluded; these patients may differ systematically in their clinical profile and cost patterns. Information bias was minimised because cost data were obtained directly from the hospital billing system; both indirect costs and out-of-pocket expenditures outside the hospital were not captured. As this analysis was limited to the hospital perspective, societal and indirect costs were not captured. Hence, the actual economic benefit of MDP implementation may even be greater than estimated. Because the data were drawn from the 2018 billing records, potential bias related to inflation and changes in healthcare pricing structures cannot be excluded. The findings should be interpreted with caution, as they may not fully capture current economic conditions or the broader healthcare setting. Consequently, the reported costs may underestimate the current financial burden of chronic heart failure management.

CONCLUSION

The implementation of MDP for CHF at tertiary referral hospitals in Indonesia was associated with higher clinical effectiveness and a significant reduction in overall hospital cost compared with standard care. Higher outpatient expenditures were offset by substantially lower inpatient costs, supporting MDP as a feasible and cost-effective strategy to optimize care within resource-limited health systems.

ACKNOWLEDGMENTS

This study received no specific grant from any funding organization.

CONFLICT OF INTERESTS

The authors declare no conflict of interest.

AUTHOR CONTRIBUTION

Conceptualization = LR, NA; Methodology = LR, NA, MN; Validation = NA; Formal analysis = LR; Investigation = LR, NA; Data curation = LR, NA; Writing - original draft = LR; Writing - review & editing = LR, NA, MN, IA; Visualization = LR; Supervision = IA; Project administration = LR.

REFERENCES

- Reyes EB, Ha JW, Firdaus I, et al. Heart failure across Asia: same healthcare burden but differences in organization of care. *Int J Cardiol*. 2016;223:163-7.
- Feng J, Zhang Y, Zhang J. Epidemiology and burden of heart failure in Asia. *JACC Asia*. 2024 Mar 19;4(4):249-64. doi:10.1016/j.jacasi.2024.01.013. PMID: 38660101; PMCID: PMC11035951.
- Eguchi S, Morita Y, Mitani H, et al. Burden of repeated hospitalizations on patients with heart failure: an analysis of administrative and claims data in Japan. *Drugs Real World Outcomes*. 2022;9(3):377-89. doi:10.1007/s40801-022-00315-5
- Savarese G, Lund LH. Global public health burden of heart failure. *Card Fail Rev*. 2017;3(1):7-11. doi:10.15420/cfr.2016:25:2.
- Indriany FE, Siregar KN, Purwowiyoto BS, Siswanto BB, Sutedja I, Wijaya HR. Predicting the risk of severity and readmission in patients with heart failure in Indonesia: a machine learning approach. *Health Inform Res*. 2024 Jul;30(3):253-65. doi:10.4258/hir.2024.30.3.25
- Lam CSP, Wood R, Vaduganathan M, et al. Contemporary economic burden in a real-world heart failure population with commercial and Medicare supplemental plans. *Clin Cardiol*. 2021;44(5):646-55. doi:10.1002/clc.23585.
- Gouveia M, Ascensão R, Fiorentino F, et al. The current and future burden of heart failure in Portugal. *ESC Heart Fail*. 2019;6(2):254-61. doi:10.1002/ehf2.12399.
- Senanayake S, Kularatna S, Lee ASY, et al. Health services costs of clinical heart failure with reduced ejection fraction in Singapore. *Value Health Reg Issues*. 2025 Jan;45:101037. doi:10.1016/j.vhri.2024.101037. Epub 2024 Sep 2.
- Urbich M, Globe G, Pantiri K, et al. A systematic review of medical costs associated with heart failure in the USA (2014–2020). *Pharmacoeconomics*. 2020;38(11):1219–36. doi:10.1007/s40273-020-00952-0
- Ong SC, Low JZ, Yew WY, et al. Cost analysis of chronic heart failure management in Malaysia: A multi-centred retrospective study. *Front Cardiovasc Med*. 2022;9:971592. doi:10.3389/fcvm.2022.971592
- McDonagh TA, Metra M, Adamo 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. doi:10.1093/eurheartj/ehab368
- Sokos G, Kido K, Panjath G, et al. Multidisciplinary care in heart failure services. *J Card Fail*. 2023 Jun;29(6):943–58. doi:10.1016/j.cardfail.2023.02.011.
- Ahmed M, Shafiq A, Zahid M, et al. Clinical outcomes with nurse-coordinated multidisciplinary care in patients with heart failure: a systematic review and meta-analysis. *Curr Probl Cardiol*. 2024 Jan;49(1):102041. doi:10.1016/j.cpcardiol.2023.102041. PMID: 37595855.
- Lusiani L, Adnan N. Program multidisiplin untuk pasien gagal jantung kronik untuk menurunkan angka perawatan ulang di rumah sakit. *J Penyakit Dalam Indones*. 2024;11(1):15-22.
- Davidson PM, Newton PJ, Tankumpuan T, Paull G, Dennison-Himmelfarb C. Multidisciplinary management of chronic heart failure: principles and future trends. *Clin Ther*. 2015;37(10):2225–33. doi:10.1016/j.clinthera.2015.08.021.
- Creaser JW, DePasquale EC, Vandenbogaart E, Rourke D, Chaker T, Fonarow GC. Team-based care for outpatients with heart failure. *Heart Fail Clin*. 2015 Jul;11(3):379-405. Doi: 10.1016/j.hfc.2015.03.004
- Stahlman S, Huizar-Garcia S, Lipscomb J, Frei C, Oliver A. Implementation of a heart failure educational intervention for patients with recent admissions for acute decompensated heart failure. *Front Cardiovasc Med*. 2023;10:1133988. doi:10.3389/fcvm.2023.1133988
- Coons JC, Klinier J, Mathier MA, Mulukutla S, Thoma F, Sezer A, Keebler M. Medication optimization clinic decreases hospitalizations and mortality for patients with heart failure with reduced ejection fraction. *Am Heart J Plus*. 2024;47:100470. doi:10.1016/j.ahjo.2024.100470. PMID: 39503006; PMCID: PMC11535887.
- Muk B, Bánfi-Bacskárdi F, Vámos M, et al. The impact of specialised heart failure outpatient care on the long-term application of guideline-directed medical therapy and on prognosis in heart failure with reduced ejection fraction. *Diagnostics (Basel)*. 2024;14(2):131. doi:10.3390/diagnostics14020131
- Tan SS, Hisham SA, Abdul Malek AM, Chua PL, Lau SKG, Abdul Ghapar AK. Impact of multidisciplinary heart failure clinic on guideline-directed medical therapy and clinical outcomes. *Can J Hosp Pharm*.

- 2024;77(1):10–7. doi:10.4212/cjhp.3364.
21. Sousa O, Ponte M, Caeiro D, Pereira E, Silva M, Pestana S, Braga P, Fontes-Carvalho R. Excellence in heart failure: a multidisciplinary program on heart failure management for improved patient outcome. *Hearts*. 2024;5(1):1-13. doi:10.3390/hearts5010001.
22. Bánfi-Bacsárdi F, Ráduly AP, Borbély A, et al. The feasibility of a guideline-directed medical therapy rapid up-titration programme among real-world heart failure patients: A multicentre observational study. *J Clin Med*. 2025;14(10):3611.
23. Huynh QL, Negishi K, Blizzard L, et al. Mild cognitive impairment predicts death and readmission within 30 days of discharge for heart failure. *Int J Cardiol*. 2016;221:212–7. doi:10.1016/j.ijcard.2016.07.074.
24. Chen SM, Fang YN, Wang LY, et al. Impact of multidisciplinary treatment strategy on systolic heart failure outcome. *BMC Cardiovasc Disord*. 2019;19:220. doi:10.1186/s12872-019-1214-0.
25. Perea-Armijo J, López-Aguilera J, González-Manzanares R, et al. The worsening of heart failure with reduced ejection fraction: The impact of the number of hospital admissions in a cohort of patients. *J Clin Med*. 2023;12(18):6082. doi:10.3390/jcm12186082.
26. Soloveva AE, Gorbacheva TV, Solovev AE, Villevalde SV, Zvartau NE, Shlyakhto EV. Cumulative incidence and prognostic value of readmissions in patients with heart failure: Data from a large cohort study of real clinical practice in St. Petersburg. *Kardiologiya*. 2024;64(11):96–105. doi:10.18087/cardio.2024.11.n2781.
27. Vader JM, LaRue SJ, Stevens SR, et al. Timing and causes of readmission after acute heart failure hospitalization: Insights from the Heart Failure Network trials. *J Card Fail*. 2016;22(11):875–83. doi:10.1016/j.cardfail.2016.04.014.
28. Reinhardt SW, Clark KAA, Xin X, et al. Thirty-day and ninety-day episode of care spending following heart failure hospitalization among Medicare beneficiaries. *Circ Cardiovasc Qual Outcomes*. 2022;15(7):e008069. doi:10.1161/CIRCOUTCOMES.121.008069.
29. Nadhiasari A, Pribadi F, Nazaruddin I. Unit cost analysis in heart failure inpatients using the time-driven activity-based costing method at type D hospital in Sragen. *J Health Policy Manage*. 2025;10(1):1-15. doi:10.26911/thejhp.2025.10.01.0
30. Lares PA, Perelman J, Martins E, et al. The current and future burden of heart failure in Portugal: a cost of illness study. *Rev Port Cardiol*. 2020;39(3):139-48. doi:10.1016/j.repc.2019.06.010
31. Wei C, Heidenreich PA, Sandhu AT. The economics of heart failure care. *Prog Cardiovasc Dis*. 2024;82:90-101. doi:10.1016/j.pcad.2024.01.010.
32. Riley JP, Beattie JM. Palliative care in heart failure: facts and numbers. *ESC Heart Fail*. 2017;4(2):81-7. doi:10.1002/ehf2.12125
33. Lam CSP, Owen A, McMurray JJV, et al. Cost of heart failure in Asia: insights from Singapore. *Eur J Heart Fail*. 2018;20(10):e1-3. doi:10.1002/ejhf.1335.
34. Poelzl G, Egelseer-Bruendl T, Jahn B, et al. Cost-effectiveness of HerzMobil Tirol, a multidimensional post-discharge disease management program for heart failure patients: economic evaluation along a one-year observation period. *Eur Heart J*. 2023;44(Suppl_2):ehad655.1051. doi:10.1093/eurheartj/ehad655.1051
35. Rego R, Pereira N, Pinto A, Pereira S, Marques I. Impact of a heart failure multidisciplinary clinic on the reduction of healthcare-related events and costs: the GESTIC study. *ESC Heart Fail*. 2021;8(5):3856-65. doi:10.1002/ehf2.13480
36. Iovino P, D'Angelo D, Vellone E, Ruggeri M. A cost-effectiveness analysis of community nurse-led self-care education for heart failure patients. *Collegian*. 2024;31(4):258-66. doi:10.1016/j.colegn.2024.05.003
37. Weinstein JM, Greenberg D, Sharf A, Simon-Tuval T. The impact of a community-based heart failure multidisciplinary team clinic on healthcare utilization and costs. *ESC Heart Fail*. 2022;9(2):676-684. doi:10.1002/ehf2.13689
38. Yu DSF, Li PWC, Li SX, et al. Effectiveness and cost-effectiveness of an empowerment-based self-care education program on health outcomes among patients with heart failure: a randomized clinical trial. *JAMA Netw Open*. 2021;4(6):e2111919. doi:10.1001/jamanetworkopen.2021.11919
39. Alayoubi F, Hayajneh A, Alam T, Asfina KN. Cost of heart failure in-patient in Saudi Arabia: role of heart failure multidisciplinary program. *Cardiol Res Rep*. 2023;5(1):9. doi:10.31579/2692-9759/083.
40. Driscoll A, Gao L, Watts JJ. Clinical effectiveness and cost-effectiveness of ambulatory heart failure nurse-led services: an integrated review. *BMC Cardiovasc Disord*. 2022;22:64. doi:10.1186/s12872-022-02509-9
41. Khongmee T, Torpongpan A, Intarachumnum S, Kulthanachairojana N. Cost-utility analysis of specialized multidisciplinary care versus standard care in the management of patients with reduced ejection fraction heart failure in Thailand. *J Med Assoc Thai*. 2022;105(8):719-23. doi:10.35755/jmedassocthai.2022.08.13442

SUPPLEMENTARY TABLES

Supplementary Table 1. Sensitivity and Specificity of Various Cut-off Points for Cumulative Hospital Readmissions in Predicting Mortality

Cumulative number of Readmissions	Sensitivity (%)	Specificity (%)	LR+	LR-
≥ 0	100,00%	0,00%	1,0000	-
≥ 1	66,67%	81,87%	3,6774	0,4071
≥ 2	16,67%	93,57%	2,5909	0,8906
≥ 3	0,00%	97,08%	<0,0001	1,0301
≥ 4	0,00%	99,42%	<0,0001	1,0059
≥ 5	0,00%	100,00%	-	1

LR= *Likelihood Ratio***Supplementary Table 2. VIF**

Variable	VIF	1/VIF
Age	2,18	0,458
Comorbidities	2	0,500
Etiology	1,46	0,683
MDP	1,44	0,694
LVEF	1,44	0,695
ARNI	1,43	0,697
Gender	1,19	0,838
NYHA	1,16	0,861
BMI	1,15	0,871
Device Therapy	1,14	0,877
Anemia	1,13	0,883
VIF	1,43	

ARNI = Angiotensin Receptor–Neprilysin Inhibitor; BMI = Body Mass Index; MDP = Multidisciplinary Program; NYHA = New York Heart Association; SC = Standard Care

Supplementary Table 3. Correlation Test for Variable Collinearity

	Effective	MDP	Age	Gender	Etiology	Comorbidities	BMI	ARNI	Device Therapy	Anemia	NYHA	LVEF
Effective	1											
MDP	0.2601	1										
Age	-0.0196	-0.2069	1									
Gender	-0.0448	-0.043	0.049	1								
Etiology	-0.0272	-0.125	0.309	0.1578	1							
Comorbidities	0.0339	-0.0496	0.6747	0.1101	0.223	1						
BMI	0.0702	-0.012	-0.0692	-0.0723	0.2636	-0.1001	1					
ARNI	0.0431	0.435	0.0099	0.0351	0.0908	0.0983	0.0459	1				
Device Therapy	0.0478	-0.1147	0.1408	-0.0392	-0.1714	0.1338	-0.0461	-0.067	1			
Anemia	-0.0157	0.0779	0.0929	-0.1293	-0.1362	-0.0525	-0.0762	-0.0301	-0.0929	1		
NYHA	-0.1718	-0.2676	0.0992	-0.0663	0.0763	0.0873	-0.0704	-0.1097	0.0406	-0.0666	1	
LVEF	0.0181	-0.0087	-0.0233	-0.318	-0.266	-0.0132	0.0051	-0.2977	-0.0546	0.1956	-0.167	1

ARNI = Angiotensin Receptor–Neprilysin Inhibitor; BMI = Body Mass Index; MDP = Multidisciplinary Program; NYHA = New York Heart Association; SC = Standard Care.