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Reducing heart failure events via individualized patient education program in patients with reduced ejection fraction

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ABSTRACT

Background: Disease management programs for heart failure (HF) often include various strategies such as medication management and lifestyle modifications, and are known to improve clinical outcomes.
Objectives: To evaluate the effectiveness of an individualized patient education program (IPEP) specifically designed for patients with reduced ejection fraction (HFrEF) on clinical outcomes.
Methods: In our prospective interventional study involving 164 patients, participants were divided into control (CG) and intervention (IG) groups. The IG received the IPEP facilitated by the academic pharmacist, while both the IG and the CG continued to receive standard care from the healthcare team without any differences in the care provided. Self-care practices, medication adherence, quality of life, and clinical outcomes were assessed at both the 6th and 12th months. Statistical analysis included Chi-square tests, Kaplan-Meier survival plots, and Multivariable Cox proportional regression analysis. Data analysis was conducted using JAMOVI and R software.
Results: The demographic and clinical characteristics of sample population were largely homogeneous in both the groups. The unadjusted 1-year rehospitalization (RH) rate was significantly lower in the IG at 33 % compared to 48 % in the CG, with a hazard ratio of 0.55 (95 % CI: 0.34–0.90, $p = 0.018$). Kaplan-Meier survival analysis depicts a higher RH rate for HFrEF participants over time, with a significant difference observed between CG and IG (log-rank $P = 0.017$). Notable disparities in self-care practices emerged & at the 6th and 12th-month assessments medication adherence & QoL were significantly improved in the IG ($p \leq 0.001$).
Conclusion: IPEP led by an academic pharmacist resulted in improved self-care practices, enhanced quality of life, and reduced one-year rehospitalization rates.

Introduction

Heart failure with reduced ejection fraction (HFrEF) is a chronic and debilitating clinical condition characterized by structural or functional constraints in the left ventricle, resulting in diminished ability to pump blood effectively (left ventricular ejection fraction (LVEF) $\leq$ 40 %). HFrEF is linked to a notably heightened risk of both rehospitalisation (RH) and mortality, with up to 44 % of patients requiring readmission within six months of post discharge, adversely affecting their quality of life (QoL).[1, 2] In India, the prognosis for HFrEF appears particularly severe, as indicated by previous data, highlighting the need to prioritize key factors to address the escalating rates of RH and mortality.[3, 4] Various international guidelines have recognized the importance of patient self-care measures, and prior studies have affirmed this stance.

Abbreviations: CCU, Critical Care Unit; CG, Control Group; DM, Diabetes Mellitus; EF, Ejection Fraction; GDMT, Guideline Directed Medical Therapy; HF, Heart Failure; HFrEF, Heart Failure with Reduced Ejection Fraction; HTN, Hypertension; IG, Intervention Group; MERIT-HF, Metoprolol CR/XL Randomized Intervention Trial in Congestive Heart Failure; MGLS, Morrisky Green Levine Score; NYHA, New York Heart Association; QoL, Quality of Life; RH, Rehospitalization; PEP, Patient Education Program.

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There is unequivocal evidence of the benefits of discharge advice along with various post-discharge education programs, particularly in the reduction of RH rates.[2, 5] Research supports these findings, suggesting that disease management initiatives may reduce readmissions due to heart failure (HF) by up to 56 % and all-cause readmissions by 44 %.[6]

Patients should profoundly understand how beneficial healthy interventions can be for their current and future health. Improving healthcare outcomes requires healthcare teams to allocate more time to patient care. Interactions with patients should be characterized by enthusiasm, motivation, and attentiveness to their individual needs. Achieving the full benefits of individualized patient education programs (IPEP) for members of our society demands a strong and genuine engagement between patients and the healthcare team. Considering these factors, an individualized care plan developed with the help of a multidisciplinary team is crucial for managing HFrEF patients. This approach ensures comprehensive and integrated care, providing broader benefits to the patient. Healthcare professionals from various disciplines work together to develop a cohesive care plan, leading to improved patient outcomes, enhanced QoL, and reduced hospital readmissions.

The prevalence of HF significantly escalates with increasing age. Among the various causes of HF exacerbations requiring hospitalization, medication, and dietary non-compliance emerge as significant factors, identified in up to 33 % of hospitalized patients. Non-adherence to pharmacotherapy impacts 20–50 % of all patients and significantly affects morbidity and mortality in those with reduced ejection fraction (EF). The pharmacological treatment for patients with reduced EF, through Guideline-Directed Medical Therapy (GDMT), is well-established. Adherence to GDMT is paramount in this context. IPEP have focused on personalized discharge counseling, HF education employing patient information leaflets (PILs) and educational videos, dietary instruction, assessment of medication adherence and subsequent telephone monitorung.[7, 8] In India, while numerous studies focus on the general HF population, there is a scarcity of research specifically targeting patients with reduced EF, and no pharmacist-led multidisciplinary studies aim to improve clinical outcomes in HFrEF patients through structured, regular, and long-term patient interactions. Therefore, we hypothesize that implementing an IPEP will significantly improve prognosis, QoL, medication adherence, and reduce HF-related rehospitalization in HFrEF patients compared to those receiving routine care in the control group.

Methods

Study design and population

In a prospective interventional study, we assessed the impact of an IPEP on readmissions and mortality among 164 patients with reduced EF. We included patients with an EF $\leq$ 40 %, who were hemodynamically stable and aged over 18. The exclusion criteria were, those diagnosed with valvular heart disease, congenital heart disease, cancer, psychiatric disorders, or those who were immunocompromised or critically ill, pregnant and lactating women.[9] All eligible patients admitted to the Coronary Care Unit (CCU) between 2022 and 2024 were invited to participate, and informed consent was obtained from those who agreed. The study was approved by the Central Ethics Committee, reference number NU/CEC/2022/319.

Study protocol

Participants were randomly allocated to either the control group (CG) or intervention group (IG) using a chit method. This study was carried out by an academic pharmacist focused on implementing an IPEP using well-designed educational materials such as Patient Information Leaflets (PILs) and HF educational videos. These educational resources were collaboratively developed and validated with the input of a multidisciplinary team comprising cardiologists, nurses, dietician, physiotherapist and various other healthcare professionals. While the IG received IPEP facilitated by the academic pharmacist using these materials, both the IG and CG continued to receive standard care from the healthcare team without any difference. The IPEP comprised a 30-minute one-on-one teaching session prior to discharge. This session utilized a PIL entitled "Patient Education Leaflet for Heart Failure with Reduced Ejection Fraction," validated by a committee of 12 experts using the Lawshe method. The information in the PIL was reinforced through HF educational videos, which were also validated by an 8-member expert committee using the Delphi procedure. Both educational tools address various aspects of HFrEF, including its symptoms, risk factors, complications, warning signs, and lifestyle modifications. Disease and drug counseling, along with lifestyle changes, were individualized based on clinical parameters with input from the treating physician. The diet chart was prepared with the dietician's assistance, and exercise guidance was tailored to each patient's NYHA class with help from the physiotherapist. Additionally, the IPEP emphasized self-care practices such as maintaining a HF diary, monitoring weight daily, quitting smoking, moderating alcohol consumption, avoiding non-steroidal anti-inflammatory drugs, and understanding appropriate steps to take if symptoms worsen. Social media platforms, specifically WhatsApp, were utilized in this study. After the counseling session, both hard and soft copies of the PIL were distributed to the patients, and HF educational videos were sent to their phones at regular intervals.

A structured proforma was developed and validated with the help of an eight-member multidisciplinary expert committee by Lawshe method. This proforma was used to gather data at three distinct intervals: upon discharge (baseline), at six months, and at twelve months post-discharge. It included various sections, focusing on different aspects of data collection, such as demographic details, patient history, prescription patterns, clinical assessments, and self-care behaviours. Clinical parameters such as body weight, heart rate, respiratory rate, blood pressure, signs of fluid overload, NYHA class, lipid profile, left ventricular ejection fraction, haemoglobin, sodium, potassium, creatinine, urea, uric acid, and blood sugar were collected from the patient's case sheets, while patient history and self-care behaviours were assessed through structured interview. To address the limitations of data obtained through interview, we cross-verified patient responses with caregiver responses and medical records. We clearly communicated the purpose of data usage and ensured the confidentiality of personal information. Data collection occurred during follow-up visits and telecommunication was used to monitor patients and remind them to attend follow-up appointments with their doctor.

In the current study, medication adherence and QoL were assessed using validated questionnaires: the Morisky Green Levine Scale (MGLS) and the Minnesota Living with Heart Failure Questionnaire (MLHFQ). We assessed the reliability of these questionnaires in the regional languages (Kannada and Malayalam) by test-retest method before their use. The MGLS is a four-item questionnaire. In this scale, an answer of "yes" receives zero points, while an answer of "no" earns one point. Scores range from zero to four, with higher scores indicating better medication adherence.[10]The MLHFQ is a reliable tool for assessing how heart failure affects a patient's QoL. There are twenty one questions addressing the physical, emotional, and socioeconomic domains. A maximum score of 105 can be achieved by scoring each question from zero to five. The higher the score, the more significant the impact of heart failure on a person's quality of life.[11]

Study endpoints

The primary endpoint of the study was to evaluate the effect of IPEP on HF events, specifically RH and mortality by improving medication adherence and QoL. RH details were collected directly from the patients' case sheets during their hospital/emergency visits, and data on mortality were obtained from the medical records department (MRD). The secondary endpoints were to assess the combined impact of IPEP and

GDMT on survival rates, aiming to determine if integrating these interventions reduced RH rate in HFrEF patients and identify predictors of rehospitalization.

Sample size calculation

Using the following formula, we calculated a sample size of 136, resulting in 68 participants per group. The adjusted sample size was increased to 163, with 82 participants per group, to account for a 15 % attrition rate.

$$n = \frac{2\left(Z_{1-\alpha/2} + Z_{1-\beta}\right)^2 \sigma^2}{d^2}$$

Where, $Z_{1-\alpha/2}$=1.96 at a 5 % level of significance, $Z_{1-\beta}$=90%, $d = 0.5$ and σ = pooled standard deviation.

Statistical analysis

Statistical findings were presented as the mean and standard deviations for continuous variables, while frequencies and percentages were used for categorical variables. Both Chi-square and Fisher's exact tests were used to evaluate the relationship between categorical parameters in the CG and IG. A Kaplan-Meier survival plot and log-rank statistics were used to compare the time and RH between groups. Univariate Cox proportional hazard analysis was conducted to identify significant factors, followed by a semi-parametric survival model designed using the significant factors through Multivariable Cox proportional regression analysis. Participants with missing follow-up data were treated as right-censored in the analysis. A p-value of <0.05 was considered statistically significant. Using JAMOVI and R software, data was analyzed and results were described in text descriptions, tables, and graphs.

Results

Baseline characteristics

Of the 164 initially enrolled patients, 141 completed the study (CG=69, IG=72). The demographic characteristics were largely homogeneous, with the majority being male and having an average age ranging from 58 to 61 years. Ischemia was identified as the major cause of HF (CG=66 %, IG=71 %), followed by non-ischemic factors such as hypertension/diabetes mellitus (HTN/DM) (CG=18 %, IG=13 %). The majority of participants in both cohorts reported a history of smoking and alcohol consumption (Table 1).

Evaluation of self-care practices one month post-discharge

There was a notable difference in self-care practices, including adhering to specific sodium and fluid restrictions, avoiding smoking, keeping a heart failure diary, and exercising at least thrice weekly (Table 2).

Evaluation of medication adherence, quality of life and clinical parameters

In terms of medication adherence, no statistically significant differences were found between the groups at baseline (mean±SD, CG=2.09 ±0.97, IG=2.11±0.97, $p = 0.87$) or QoL (mean±SD, CG=57.12±11.83, IG=56.88±11.01, $p = 0.8$). However, medication adherence significantly improved in the IG at six and twelve months ($p \leq 0.001$). Notably, OoL showed a significant difference only at the 12th month (Mean±SD, CG=52.01±12.89, IG=44.06±13.45, $p \leq 0.001$). At the 12-month follow-up, there were no statistically significant differences in clinical parameters between the CG and the IG, except for sodium and uric acid levels. (Table 3).

Table 1
Comparison of baseline demographic and clinical characteristics between control and intervention groups.

Parameters	Variables	CG (n = 82)	IG (n = 82)	P value
Gender, n (%)	Male	63 (76.8)	60 (73.1)	0.2
	Female	19 (23.1)	22 (26.8)	
Educational status, n (%)	Up to primary	40 (48.7)	43 (52.4)	1.7
	Secondary	35 42.6)	28 (34.1)	
	Graduate and above	7 (8.5)	11 (13.4)	
Aetiology, n (%)	Ischemic	49 (59.7)	35 (42.6)	4.9
	Non-ischemic (HTN, T2DM)	24 (29.2)	36 (43.9)	
	Valvular	9 (10.9)	11 (13.4)	
Tobacco use, n (%)	Never used	27 (32.9)	29 (35.3)	0.5
	Current use	32 (39)	34 (41.4)	
	Past use	23 (28)	19 (23.1)	
Alcohol use, n (%)	Never used	32 (39)	28 (34.1)	0.4
	Current use	15 (18.2)	17 (20.7)	
	Past use	35 (42.6)	37 (45.1)	
Past Medical History, n (%)	Hypertension/ Diabetes	53 (64.6)	48 (58.5)	0.07
	Atrial fibrillation/ flutter	11 (13.4)	9 (10.9)	0.2
	Stroke	13 (15.8)	11 (13.4)	0.1
	COPD	6 (7.3)	7 (8.5)	0.08
	CKD	14 (17)	10 (12.1)	0.7
	Hypothyroidism	6 (7.3)	8 (9.7)	0.3
NYHA functional class, n (%)	I	7 (8.5)	12 (14.6)	2.5
	II	39 (47.5)	32 (39)	
	III	29 (35.4)	28 (34.1)	
	IV	7 (8.5)	10 (12.2)	

Abbreviation: CG; Control Group, **IG;** Intervention Group, **NYHA;** New York Heart Association, **COPD;** Chronic Obstructive Pulmonary Disease, **CKD**; Chronic Kidney Disease, **SD**; Standard Deviation, **n**; number of patients.

Table 2
Self-care practices at 30-Day and 12th month follow-up.

Activities	30-Day follow-up		P value	12th month follow-up		P value
	CG (n = 81)	IG (n = 82)		CG (n = 69)	IG (n = 72)	
Performing daily weight	12	23	0.03*	9	39	0.001*
Following specific sodium restriction	34	67	0.01*	39	56	0.007*
Following specific fluid restriction	29	46	0.009*	31	54	0.001*
No smoking	43	57	0.03*	44	61	0.004*
maintaining HF diary	3	17	0.001*	4	24	0.001*
Performing exercise ≥3 times per week	21	39	0.004*	18	41	0.001*

Abbreviation: CG; Control Group, **IG;** Intervention Group, *statistically significant.

Table 3
Assessment of medication adherence, quality of life and clinical parameters between control and intervention.

Medication adherence			
MGLS Score (0–4)	CG	IG	P value
Baseline	2.09 ± 0.97	2.11 ± 0.97	0.87
6th month follow-up	2.39± 1.00	3.15±1.03	<0.001*
12th month follow-up	2.50± 0.88	3.51± 0.79	<0.001*
Quality of Life			
MLHFQ Total score (0–105)			
Baseline	56.93±13.18	56.79±11.95	0.4
6th month follow-up	49.23±17.99	50.03±15.74	0.8
12th month follow-up	51.77±14.57	43.9 ± 14.36	<0.001*
Physical domain (0–45)			
Baseline	23.69±6.34	23.62±5.87	0.95
6th month follow-up	20.93±8.63	21.17±7.32	0.33
12th month follow-up	21.82±6.48	19.08±6.41	0.13
Emotional domain (0–25)			
Baseline	15.68±3.16	15.20±2.64	0.29
6th month follow-up	13.09±4.78	13.24±3.84	0.83
12th month follow-up	13.94±4.09	11.09±3.79	<0.001*
Socio-economic domain (0–35)			
Baseline	17.56±3.68	17.97±3.44	0.45
6th month follow-up	15.21±5.01	15.62±4.58	0.59
12th month follow-up	16.01±4.00	13.73±4.16	<0.001*
Clinical parameters			
Ejection fraction (%)			
Baseline	31.65 ± 8.50	29.02± 7.85	0.04
6th month follow-up	35.25± 9.24	34.78± 8.38	0.74
12th month follow-up	33.91± 7.88	36.51± 7.93	0.056*
Systolic blood pressure (mmHg)			
First visit	140.47± 22.25	144.45± 25.66	0.29
6th month follow-up	136.44± 16.94	138.60± 23.46	0.51
12th month follow-up	133.62± 11.90	131.94± 16.15	0.48
Diastolic blood pressure (mmHg)			
First visit	83.20± 12.94	81.24 ± 12.39	0.32
6th month follow-up	81.35± 9.59	81.03± 11.59	0.85
12th month follow-up	80.33± 8.74	80.58± 10.96	0.48
Heart rate (beats/min)			
First visit	83.67± 13.42	86.64±9.99	0.11
6th month follow-up	79.92± 8.70	80.57 ± 7.15	0.61
12th month follow-up	78.73± 8.30	79.76± 7.65	0.44
Body mass index (kg/m2)			
First visit	24.69 ± 2.58	25.09±3.54	0.41
6th month follow-up	24.99 ± 2.36	25.26 ± 3.45	0.58
12th month follow-up	25.67± 2.24	25.63 ± 3.66	0.93
Hemoglobin (g/dl)			
Baseline	12.67± 2.32	12.42± 1.86	0.43
6th month follow-up	13.32± 2.57	12.73± 1.99	0.11
12th month follow-up	13.09± 2.46	13.73± 2.09	0.09
Potassium (mEq/L)			
Baseline	4.32± 0.68	4.35± 0.62	0.47
6th month follow-up	4.09 ± 0.66	4.13 ± 0.64	0.70
12th month follow-up	4.31 ± 0.67	4.13 ± 0.62	0.10
Sodium (mEq/L)			
Baseline	133.64 ± 15.76	136.32 ± 4.92	0.14
6th month follow-up	133.12 ± 16.7	137 ± 5.46	0.06
12th month follow-up	132.31± 17.45	136.76 ± 5.19	0.04*
Creatinine (mg/dL)			
Baseline	1.27± 0.61	1.07± 0.29	0.007
6th month follow-up	1.13 ± 0.63	1.02± 0.36	0.22
12th month follow-up	1.16 ± 0.65	1.03 ± 0.29	0.13
Urea (mmol/L)			
Baseline	30.72 ± 17.40	29.82 ± 11.69	0.70
6th month follow-up	30.55 ± 17.21	30.82± 11.75	0.91
12th month follow-up	32.90 ± 17.67	31.58 ± 10.71	0.59
Uric acid (mg/dL)			
Baseline	5.84±2.50	5.65±2.73	0.65
6th month follow-up	6.03 ± 2.62	5.78 ± 2.49	0.53
12th month follow-up	6.72 ± 2.78	5.86 ± 1.95	0.04*
Random Blood Sugar (mg/dL)			
Baseline	154.63 ± 61.20	159.36 ± 53.95	0.60
6th month follow-up	147.94± 56.43	149.32 ± 34.99	0.85
12th month follow-up	144.00 ± 48.82	142.97 ± 29.33	0.88
Total cholesterol (mg/dL)			
Baseline	208.36±42.88	214.03±49.57	0.43
6th month follow-up	195.69 ± 34.40	199.10 ± 45.60	0.60
12th month follow-up	193.42 ± 32.23	191.31 ± 38.69	0.72
Triglycerides (mg/dL)			
Baseline	179.07 ± 52.08	175.61 ± 53.68	0.67
6th month follow-up	169.35 ± 42.30	167.05 ± 43.67	0.73
12th month follow-up	166.33 ± 40.21	159.86 ± 40.50	0.34
Low Density Lipoprotein (mg/dL)			
Baseline	134.58 ± 38.14	140.63 ± 40.83	0.32
6th month follow-up	129.90 ± 31.39	130.94 ± 31.48	0.83
12th month follow-up	128.71 ± 31.70	127.94 ± 28.29	0.88
High Density Lipoprotein (mg/dL)			
Baseline	40.27 ± 10.37	39.57 ± 9.06	0.64
6th month follow-up	40.27± 7.81	41.02 ± 9.21	0.58
12th month follow-up	41.15 ± 7.15	41.12 ± 8.12	0.97

Abbreviation: CG; Control Group, **IG;** Intervention Group, **MGLS;** Morisky Green Levine Scale, **MLHFQ;** Minnesota Living with Heart Failure Questionnaire, *statistically significant.

Impact of PEP on clinical outcomes

The unadjusted 1-year RH rate was significantly reduced in the IG (33 %) compared with CG (48 %, hazard ratio {HR} 0.55, (95 % CI: 0.34–0.90, $p = 0.018$). Specifically, in the CG, 30 patients had no RH, 23 were rehospitalized once, 7 were rehospitalized twice, and 9 were rehospitalized three times. In the IG, 45 patients had no RH, 16 were rehospitalized once, 6 were rehospitalized twice, and 5 were rehospitalized three times. In spite of the efforts made, no significant difference was found in the mortality rate between the groups after the study was completed. The median duration of index hospitalization, which lasted six (4, 9) days, remained consistent across the heart failure groups (Table 4). The hospital primarily utilized Dapagliflozin as the primary SGLT2 inhibitor. Among β-Blockers, Metoprolol was the most frequently prescribed. ACEIs were preferred over ARBs/ARNIs, with Ramipril being the sole ACEI employed. Losartan emerged as the most prevalent ARB prescribed, while Spironolactone held a prominent position among MRAs, followed by Eplerenone.

Impact of PEP on survival rate

The Kaplan-Meier survival analysis (Fig. 1(a) & (b)) illustrates a higher rate of RH for HFrEF participants over time, with a significant difference observed between CG & IG (log-rank $P = 0.017$). Table 5 provides a summary of survival rates over various time intervals for both the CG and IG. Initially, in the CG, at the 1-month mark, there were 69 patients at risk, resulting in a 91.3 % survival rate (95 % CI: 84.9 % - 98.2 %) with 6 events recorded. However, this rate gradually declined over subsequent months, reaching 43.5 % (95 % CI: 33.2 % - 56.9 %) at 12 months, with 33 individuals at risk and 12 events occurring. Conversely, in the IG, survival rates were consistently higher. At 1 month, 72 individuals were at risk, with 3 events recorded and a survival rate of 95.8 % (95 % CI: 91.3 % - 100.0 %). This trend continued over the

Table 4
Comparison of clinical outcomes between the control and intervention.

Clinical events	CG, n (%)	IG, n (%)	*P* value
HF rehospitalization in 1 month	6 (7.3)	2 (2.4)	0.51
HF rehospitalization in 6 months	17 (20.7)	11 (13.4)	0.21
HF rehospitalization in 12 months	39 (47.5)	27 (32.9)	0.023*
Duration of index hospitalization, median (IQR)	6 (4–9)	6 (4–9)	0.36
Mortality in 1 month	1 (1.2)	0 (0)	0.23
Total Mortality in 6 month	3 (3.6)	1 (2.4)	0.53
Total Mortality in 12 months	5 (10.9)	3 (6)	0.45

Abbreviation: CG; Control Group, **IG;** Intervention Group, n; number of patients, HF; Heart Failure, *statistically significant.

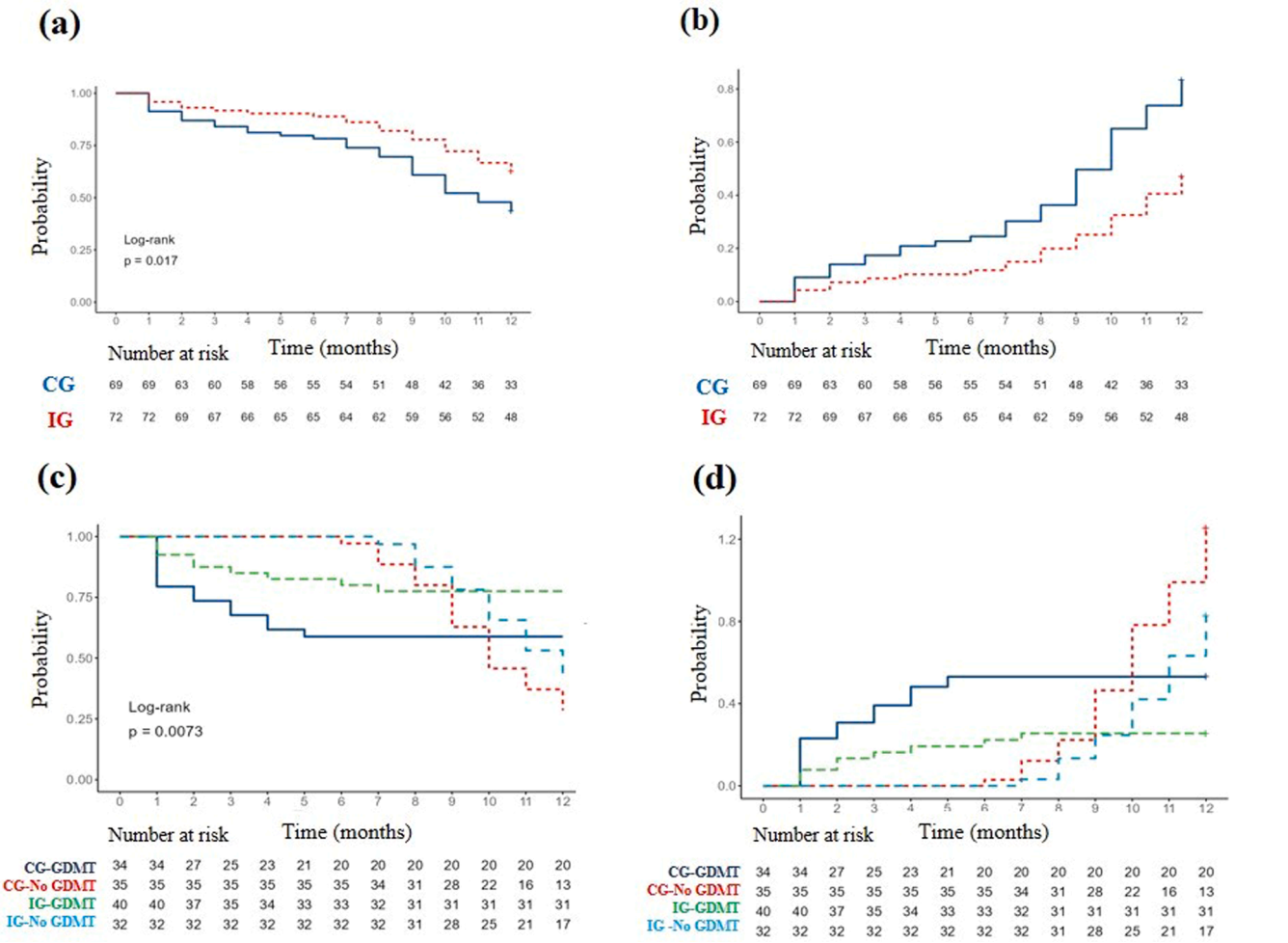

Fig. 1. Probability of event-free survival between CG & IG **(a)** probability cumulative hazard between CG & IG **(b)**, probability event-free survival between CG-No GDMT, CG-GDMT, IG-No GDMT, IG-GDMT **(c)** and probability cumulative hazard between CG-No GDMT, CG-GDMT, IG-No GDMT, IG-GDMT **(d). Abbreviation: CG**; Control Group, **IG;** Intervention Group, **GDMT**; Guideline Directed Medical Therapy.

Table 5
1, 6, and 12th month survival rate comparison between CG & IG.

Group	Time (months)	Number at Risk	Number of Events	Survival	Confidence Interval	
					Upper	Lower
CG	1	69	6	91.3 %	84.9 %	98.2 %
	6	55	4	78.3 %	69.1 %	88.6 %
	12	33	12	43.5 %	33.2 %	56.9 %
IG	1	72	3	95.8 %	91.3 %	100.0 %
	6	65	2	88.9 %	81.9 %	96.5 %
	12	48	11	62.5 %	52.3 %	74.7 %
CG-No GDMT	1	35	0	100.0 %	100.0 %	100.0 %
	6	35	1	97.1 %	91.8 %	100.0 %
	12	13	12	28.6 %	16.9 %	48.2 %
IG-No GDMT	1	32	0	100.0 %	100.0 %	100.0 %
	6	32	0	100.0 %	100.0 %	100.0 %
	12	17	11	43.8 %	29.5 %	64.8 %
CG-GDMT	1	34	7	79.4 %	66.9 %	94.2 %
	6	20	3	58.8 %	44.4 %	77.9 %
	12	20	0	58.8 %	44.4 %	77.9 %
IG-GDMT	1	40	3	92.5 %	84.7 %	100.0 %
	6	33	2	80.0 %	68.5 %	93.4 %
	12	31	0	77.5 %	65.6 %	91.6 %

Abbreviations: CG; Control Group**, IG:** Intervention Group, **GDMT;** Guideline Directed Medical Therapy.

study period, with the survival rate at 12 months being 62.5 % (95 % CI: 52.3 % - 74.7 %), with 48 individuals at risk and 11 events occurring. The data suggest that the IG consistently exhibited better survival outcomes compared to the CG across all time points, indicating the potential efficacy of the PEP in enhancing patient survival.

Tables 5 & Fig. 1(c) & (d) outline the hazard ratios of patients

stratified by GDMT within both groups (CG-GDMT, IG-GDMT, CG-No GDMT, and IG-No GDMT). Comparing patients following GDMT in both groups (CG-GDMT & IG-GDMT), those in the IG-GDMT exhibited a lower hazard ratio (HR: 0.43, 95 % CI: 0.19–1.00, $p = 0.049$). Similarly, within the No-GDMT category (CG-No GDMT & IG-GDMT), a lower risk was observed in the IG, indicating the positive impact of PEP on HFrEF patients. In both the GDMT and No-GDMT groups, patients in the IG experienced better survival rates at 1, 6, and 12 months.

Predictors of rehospitalization

The Table 6 presents hazard ratios (HR) for various variables among HFrEF, both in univariable and multivariable analyses. Patients residing in urban areas demonstrated significantly lower hazard ratios compared to those in rural areas (HR: 0.40, 95 % CI: 0.24–0.67, $p < 0.001$), which remained significant even after adjusting for other factors (HR: 0.28, 95 % CI: 0.15–0.54, $p < 0.001$). Salt restriction was associated with markedly reduced hazards (HR: 0.10, 95 % CI: 0.06–0.17, $p < 0.001$), with similar results in multivariable analysis (HR: 0.06, 95 % CI: 0.02–0.17, $p < 0.001$). The presence of diabetes mellitus (DM) significantly increased hazard ratios (HR: 7.13, 95 % CI: 2.24–22.73, $p = 0.001$), remaining significant in multivariable analysis (HR: 3.60, 95 % CI: 1.05–12.38, $p = 0.042$). Other factors such as hypertension (HTN), dapagliflozin use, ARNI/ACEI/ARB use, ejection fraction (EF), sodium levels, and age also showed significant associations with hazard ratios. These findings underscore the importance of various clinical and demographic factors in predicting hazards and informing patient management strategies.

Table 6
Multivariate Cox proportional hazard analysis to identify risk factors associated with one-year rehospitalisation among HFrEF patients.

Variables		all	HR (univariable)	HR (multivariable)
Domiciliary	Rural	70 (50.0)	–	–
	Urban	70 (50.0)	0.40 (0.24–0.67 $p < 0.001$)	0.28 (0.15–0.54 $p < 0.001$)
Salt restriction	No	40 (28.6)	–	–
	Yes	100 (71.4)	0.10 (0.06–0.17 $p < 0.001$)	0.06 (0.02–0.17 $p < 0.001$)
DM	No	29 (20.7)	–	–
	Yes	111 (79.3)	7.13 (2.24–22.73 $p = 0.001$)	3.60 (1.05–12.38 $p = 0.042$)
HTN	No	52 (37.1)	–	–
	Yes	88 (62.9)	1.91 (1.11–3.28 $p = 0.020$)	0.67 (0.36–1.26 $p = 0.213$)
Dapagliflozin	No	51 (36.4)	–	–
	Yes	89 (63.6)	0.39 (0.24–0.64 $p < 0.001$)	0.84 (0.34–1.38 $p = 0.139$)
ARNI/ACEI/ ARB	No	41 (29.3)	–	–
	Yes	99 (70.7)	0.58 (0.35–0.96 $p = 0.033$)	0.96 (0.53–1.74 $p = 0.047$)
EF	Mean (SD)	35.2 (8.0)	0.93 (0.91–0.96 $p < 0.001$)	0.97 (0.95–1.03 $p = 0.482$)
Sodium	Mean (SD)	134.5 (12.9)	0.98 (0.97–0.99 $p = 0.001$)	0.99 (0.97–1.00 $p = 0.088$)
Age	Mean (SD)	59.9 (12.0)	1.02 (1.00–1.04 $p = 0.045$)	1.63 (1.01–1.96 $p = 0.007$)

Abbreviations: HFrEF; Heart Failure with Reduced Ejection Fraction, **DM;** Diabetes Mellitus, **HTN:** Hypertension, **EF;** Ejection Fraction, **ARNI;** Angiotensin Receptor/Neprilysin Inhibitor, **ACE-I;** Angiotensin-Converting Enzyme Inhibitors, **ARB;** Angiotensin Receptor Blockers, **EF**; Ejection Fraction, **SD;** Standard Deviation, **HR**; Hazard Ratio.

Discussion

The high patient volume in India challenges cardiologists to allocate sufficient time to patient education.[12] Time is critical in any educational process, particularly in developing patient health literacy.[7] The need for more doctors, especially in rural areas, hampers their active engagement in locally relevant clinical research. Medical sociologists depict patients as victims of relational asymmetry, medical sovereignty, and professional exploitation.[13, 14] HF patients, especially in countries like India, face limited access to health information, often traveling long distances for healthcare and harbouring concerns about quality of care.[15] Integrating pharmacists into the healthcare team is essential for proactive pharmaceutical care, a practice that has yet to be widespread in India.[16] Enhancing healthcare delivery through empowering self-care via IPEP is paramount in this context. The management approach for each patient is individualized based on various factors such as their care goals, socio-economic status, educational background, and support network. Ensuring affordability of medications and providing feasible dietary recommendations are crucial aspects of care. Studies like the Pharmacist in Heart Failure Assessment Recommendation and Monitoring (PHARM) study have demonstrated the potential benefits of integrating pharmacists into heart failure management teams to improve patient outcomes and care quality. This study provides initial evidence that offering patient education at discharge, combined with timely follow-up and counseling by a pharmacist, leads to improved clinical outcomes for individuals with reduced ejection fraction (EF) in India.

The age distribution and male-to-female ratio among the enrolled patients closely resembled previous observations, indicating that individuals of Indian descent tend to develop HF at a younger age compared to those in the US, with the overall male-to-female ratio in this study approximately 80:20, consistent with prior research.[17] Common comorbidities such as HTN and DM were prevalent among patients with HFrEF, with ischemia identified as the primary precipitating factor for decompensation in both groups, aligning with established trends in HF research.[18, 19] The period immediately following hospitalization, often referred to as the 'vulnerable phase,' carries a heightened risk of adverse clinical outcomes, particularly among patients with reduced EF. Hence, it is crucial to prioritize efforts aimed at improving self-care practices during this critical phase of heightened risk.[20] In the IG, improved clinical outcomes coincided with heightened self-care practices observed at the twelve-month follow-up. A notable rise in the percentage of patients undergoing IPEP reported daily weighing, adhered to sodium restrictions, and abstained from smoking, maintaining these practices consistently throughout their follow-up period, especially during the vulnerable phase. Expert consensus advocates for patient education as a fundamental component of standard care, with defined self-care behaviors as essential quality measures for managing HF.[21] However, specific details regarding patient education content, duration, and delivery methods remain unspecified. Noncompliance rates with HF medications have been reported to range between 20 % and 58 %, contributing to hospital readmissions. Up to 27 % of patients are rehospitalized within 90 days due to non-adherence to medication or dietary recommendations.[22] According to Neily et al. many patients need more knowledge to adhere to dietary sodium restrictions with specific instructions, indicating the potential for improvement through patient education programs.[23] Likewise, Stewart et al. documented substantial reductions in RH and mortality through a home-based nurse/pharmacist education intervention.[24] Recent randomized controlled trials, as conducted by Krumholz et al., have showcased the efficacy of structured patient education and support interventions in lowering hospital admissions and mortality rates among individuals with HFrEF.[25] In the current study, a multidisciplinary team including a treating physician, an HF-trained nurse, physiotherapist and a dietician, were also participated in the education program. Each member contributed their expertise, and their suggestions and recommendations helped design the IPEP effectively. Given the multifaceted nature of medical, social, and

economic factors contributing to high RH rates in HFrEF, a collaborative team approach is essential.[7] Multidisciplinary approaches to patient education have shown promising results. For instance, Rich et al. outlined a comprehensive program involving multiple healthcare professionals, leading to a 44 % decrease in rehospitalization risk.[6]

Although there were no initial distinctions in QoL measures between the study groups, significant improvements across all domains of the IG were observed during assessments at the 6th and 12th months. Furthermore, the results highlight the positive impact of the IPEP on bolstering medication adherence in the IG, consistent with previous literature.[26] The pharmacological treatment for heart failure patients with reduced ejection fraction (HFrEF), through Guideline-Directed Medical Therapy (GDMT), is well-established. However, in practical clinical settings, many HFrEF patients either do not receive GDMT or are prescribed doses below the recommended levels.[27] In our study's subgroup analysis, we observed that the IG had a lower RH rate, irrespective of GDMT status. This highlights the crucial role of implementing the IPEP for HFrEF patients.[28]

The unadjusted 1-year RH rate was significantly lower for participants in the IG (33 %, [HR: 0.55, 95 % CI: 0.34–0.90, $p = 0.018$]) compared to the CG (48 %). Severe HF was identified as the major contributing factor to RH in both study groups. The reduced number of RH in the IG was attributed to the provision of the IPEP, which included timely follow-up and personalized counseling. Multivariate Cox regression analysis revealed that age, domiciliary status, DM/HTN, adherence to salt restriction, use of dapagliflozin, ARNI/ACEI/ARB medications, EF, and sodium levels were independent predictors for RH. Elevated congestion, deteriorating renal function, and worsening neurohormonal dysregulation are contributing factors to early hospital readmissions in certain patient subsets. The presence of these risk factors could be utilized to effectively differentiate between low-, middle-, and high-risk subjects for HF rehospitalization. Numerous previous studies have indicated that elderly patients with HFrEF experience poorer outcomes. Elderly patients differ from younger counterparts in terms of aetiologies, comorbidities, left ventricular (LV) function (both systolic and diastolic), and treatment. Moreover, managing treatment in elderly patients is mostly complicated by multiple comorbidities, making it challenging to implement evidence-based therapies. Consistent with our study findings, Mahjoub et al. reported a significantly higher RH rate in elderly patients.[29] This study found a notable correlation between patients' domiciliary settings and rural residents exhibiting a higher RH rate. The precise mechanism remains to be determined, but it could be attributed to facility constraints hindering access to healthcare facilities for routine follow-up and lower health literacy, leading to a lack of understanding regarding the importance of timely medication adherence, resulting in hospitalization.[15]

DM is closely linked to a higher risk of HFrEF independent of coronary heart disease and hypertension. DM itself can induce diabetic cardiomyopathy, leading to LV dysfunction. Previous studies, including the Framingham Study, have confirmed the close association between DM and HF development, with the risk of HF increasing with the severity of hyperglycaemia.[30]It is essential for future practice and research to extend IPEP to a range of settings to verify its broad applicability and conduct long-term follow-ups to assess sustained benefits. Exploring the cost-effectiveness of IPEP compared to traditional management approaches could provide insights into its economic value and facilitate its broader implementation. Moreover, future research should consider the integration of advanced technologies, such as digital health tools and telemedicine, into IPEP to enhance accessibility and engagement. Individualized education programs based on patient feedback can further optimize its benefits and support wider implementation. These steps could contribute to a more comprehensive and effective approach to HFrEF management, ultimately leading to better patient outcomes and more efficient healthcare delivery.

Limitations

Several limitations of this study need to be considered. Firstly, the duration of the patient education program's effects remains uncertain, as the follow-up period was limited to one year. The study was conducted at a single center, which restricts the generalizability of the findings to the broader healthcare landscape in India. Additionally, the homogeneity of the sample further impacts generalizability, as its specific characteristics, although representative of HFrEF patients in India, may not fully reflect the diversity of patient populations across various regions and settings. The inability to implement complete blinding in the study is acknowledged as a weakness; however, the nature of the intervention precluded such blinding.

Conclusion

Implementing an IPEP, led by an academic pharmacist in collaboration with a multidisciplinary team, resulted in a significant reduction in one-year rehospitalization rates and improved survival rates for HFrEF patients in the intervention group. Additionally, participants who underwent the education program exhibited enhanced adherence to medication and disease-specific self-care practices, which leads to improved quality of life. This study stands as a pioneering effort in India, showcasing the clinical benefits of an HFrEF patient education program tailored for hospital discharge and sustained throughout the follow-up period. It underscores the importance of integrating patient education into optimal HFrEF care.

Informed consent and patient details

Authors declare that this report does not contain any personal information that could identify patients and/or volunteers.

Data availability

The data that support the findings of this study are available from Anu Philip (anuphilipjan1432@gmail.com), upon reasonable request.

CRediT authorship contribution statement

Anu Philip: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Chakrakodi Shasidhara Shastry:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Basavaraj Utagi:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Anjusha Alex:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

None.

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