RESEARCH PAPER

Impact of Clinical-Pharmacist Management on health-outcomes and Medication Adherence in Cardiovascular Disease Patients attending Tertiary Care Teaching Hospital: A RCT

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ABSTRACT
BACKGROUND: Cardiovascular disease patients often require long-term, multiple drug therapies, which increases the risk of medication non-adherence and drug-related problems, leading to poor clinical outcomes.
OBJECTIVE: To assess the impact of clinical pharmacist management model on drug related problem and medication adherence using Hill-Bone scale.
METHODOLOGY: A randomized controlled study was conducted over 10 months in the cardiology department of KLE Dr. Prabhakar Kore Hospital and medical research centre, involving both In-patients and Out-patients with cardiovascular disease. Eligible patients were randomly assigned to either a control group receiving standard medical care or an intervention group receiving clinical pharmacist-led management. The intervention included medication review, identification and resolution of drug-related problems, patient counselling, lifestyle education and adherence scale. Data were analysed using appropriate statistical tests and p-value of <0.05 was considered statistically significant.
RESULTS: A total of 220 patients were screened out of which 186 patients with cardiovascular disease were enrolled and randomized into control (n=93) and intervention (n=93) groups, with a mean age of 58.3 ± 12.1 years. Male patients constituted most of the study population and baseline demographic and clinical characteristics were comparable between the two groups. Drug-related problems were commonly identified in both groups, with drug use without indication being the most frequent category. Following the intervention, medication adherence significantly improved in the intervention group compared to the control group ($p<0.05$).
CONCLUSION: Clinical pharmacist-led management model significantly improves medication adherence and optimizes clinical outcomes in patients with cardiovascular disease.
KEYWORDS: Medication adherence; Pharmacist-led intervention; Clinical pharmacist; Hill-Bone adherence scale; Drug-related problems; Medication counselling.
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INTRODUCTION:

Cardiovascular disease (CVDs) remain the leading cause of morbidity and mortality worldwide, posing a substantial burden on healthcare systems and economics.[1] Recent global and regional epidemiological data indicate that a persistent risk in the incidence of ischemic heart disease, hypertension, myocardial infraction, arrhythmias and heart failure, particularly in low and middle income countries.[1,2] In India and other developing countries, lack of awareness, poor treatment adherence, and suboptimal risk factor control significantly contribute to adverse cardiovascular outcomes.[2,3]

Hypertension is a major modifiable risk factor for cardiovascular morbidity, including myocardial infarction, heart failure, arrhythmias and cerebrovascular disease.[3,4,5] Despite the availability of effective antihypertensive and cardioprotective therapies, blood pressure control remains inadequate in a large proportion of patients.[2,6] Additionally, emerging evidence highlights the complex interplay between metabolic dysfunction and environmental exposures in accelerating cardiovascular risk.[6,7] Poor control of these risk factors contributes to ventricular remodelling, increases myocardial wall stress, and then worsens long-term prognosis following acute cardiac events.[8,9]

Medication adherence plays a critical role in achieving optimal cardiovascular outcomes. Non-adherence to cardioprotective medications has been consistently associated with increased risks of hospitalization, disease progression and mortality. [10,11]

Hypertension is a major modifiable risk factor contributing significantly to cardiovascular disease burden.[12] Studies evaluating adherence patterns have demonstrated that psychological factors and cognitive impairment significantly influence reviews confirm that structured programs, including cardiac rehabilitation and multidisciplinary interventions, improve medication adherence and clinical outcomes.[13,14]

The COVID-19 pandemic further emphasized the importance of continuity of cardiovascular medication therapy, although population-based studies reported variable impacts on adherence patterns.[15] In parallel, randomized clinical trials have increasingly focused on adherence-enhancing interventions to improve long-term cardiovascular care.

Cohort studies such as CONSTANCES study have identified key demographic and lifestyle determinants associated with incident hypertension.[16] Clinical pharmacy services have emerged as a crucial component of multidisciplinary cardiovascular management. Pharmacist contributes through comprehensive medication review, identification and resolving drug related problems (DRPs), patients' education, dose optimization and adherence monitoring.[17,18] Educational and training interventions targeting pharmacists have demonstrated improvements in clinical practice and patient management outcomes.[19] Growing evidence supports the expanding role of clinical pharmacists in optimizing therapeutic regimens and enhancing the overall quality of cardiovascular care.[20]

Despite the expanding global evidence, there remains limited structured interventional data from tertiary care settings evaluating the direct impact of pharmacist-led management on medication adherence and clinical outcomes in cardiovascular disease patients. Most existing studies have primarily focused on observational adherence patterns.[10,11] Broader system-level interventions with comparatively fewer randomised interventional models integrated into routine hospital practice.[13]

Cardiovascular risk is further compounded by modifiable lifestyle factors. Alcohol consumption has been strongly associated with cardiac arrhythmias and adverse electrophysiological alterations.[21,22] Emerging regenerative strategies, including bioengineered fibrous scaffolds, are being explored to promote cardiac tissue repair following myocardial infarction. Persistent hypertension and ischemic injury contribute to ventricular remodelling, myocardial wall stress, and electrical instability, which may increase mortality after acute ST-elevation myocardial infraction. [23,24]

The causes of cardiac remodeling after myocardial infraction and the development of therapeutic approaches to enhance cardiovascular outcomes have also been the focus of recent developments in cardiovascular research.[25,26] additionally, sex-specific characteristics like pregnancy difficulties have been demonstrated to be important in enhancing women's cardiovascular disease risk prediction.[27] Novel interventional strategies such as renal denervation have demonstrated potential in attenuating early cardiac remodelling.[27]

Given the high burden of cardiovascular disease, the established association between medication adherence and clinical outcomes, and the evolving role of clinical pharmacists in patient-centred care, there is a need to generate robust evidence evaluating pharmacist-led interventions in real-world tertiary care setting. Therefore, the present adherence and to assess the impact of clinical pharmacist-led management on medication adherence and health outcomes among patient with cardiovascular disease.

METHODOLOGY:

A randomized, controlled interventional research study was carried out at a tertiary care teaching hospital, cardiology department (IPD/OPD) services over a period of 10 months (AUG 2025-MAY 2026). The patient with cardiovascular disease were divided into two groups at random: the intervention group, which received clinical pharmacist-led treatment, and the control group, which received usual care. Data was collected using a structured data collection form, which included demographic details, identified drug-related problems, and medication adherence. Patients were diagnosed with cardiovascular disease and receiving pharmacological treatment were screened and enrolled in the study based on predefined inclusion and exclusion criteria. The Blinding technique used in this study is a Single Blind Design where Participants were blinded. Randomization was done based upon Computer generated randomization Technique. The intervention group received structured clinical pharmacist–led care, which included medication review, patient education, and regular follow-up. CTRI Registration for the study was registered with the Clinical Trials Registry of India (CTRI) and the Registration No. for the study is (CTRI/2025/12/098382).

Inclusion Criteria

- Patients aged ≥18 years
- Diagnosed with cardiovascular disease (e.g., hypertension, ischemic heart disease, heart failure, arrhythmias)
- Prescribed one or more cardiovascular medications
- Willing to provide written informed consent

Exclusion Criteria

- Critically ill patients requiring intensive care
- Patients with severe cognitive impairment or psychiatric illness
- Pregnant or lactating women
- Patients unwilling to participate in the study.

INTERVENTION:

Medication review, patient counselling, identifying and resolving drug related issues, food and lifestyle education and adherence support were all the parts of

the intervention. A systematic data collection form was generated and used to gather clinical and demographic information. Medication adherence was tested using a validated adherence assessment instrument tool. Appropriate tests were used for statistical analysis, and p-value of less than 0.05 was known to be statistically significant.

PRIMARY OUTCOME:

Proportion of participants in normal category of BP, Identification and resolution of DRPs, Score of hill bone scale for medication adherence.

DATA COLLECTION:

Data was collected by enrolling patients from tertiary care teaching hospital, cardiology department in inpatients and outpatient. Data was collected using a structured and predesigned data collection form for all enrolled patients. Drug-related problems were identified through systematic medication review based on standard clinical guidelines and classification criteria.

Medication adherence was assessed using the validated hill-bone medication adherence scale for hypertension patients. Permission was obtained for use off the hill-bone medication adherence scale on 19/09/2025. Data collection was performed at baseline and during follow up period in both control and interventional groups. All collected information was obtained from patient interviews, medical records, treatment charts and laboratory reports while maintaining patient confidentiality.

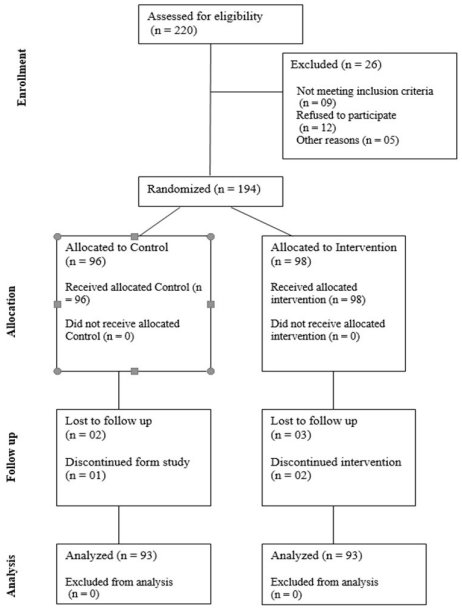

Figure 01: Consort Diagram

STATISTICAL ANALYSIS:

Data was collected and maintained by using google form. The collected data were then entered in Microsoft excel and analysed. Then the data were cleaned and imported into the IBM SPSS V29.0 for further analysis. Descriptive statistics were used to summarize demographic and clinical characteristics, including frequencies, percentage, mean and standard deviation. The continuous variables were reported as mean and standard deviation. The categorical variables were reported as frequency or percentage. Comparative analysis between the control and intervention groups were performed to assess differences in medication adherence and drug-related problems in enrolled patients. A p-value of less than 0.05 was considered statistically significant.

RESULTS:

Total of 220 patients were screened. Out of which 34 were excluded from the study due to the following reasons: 12 Did not meet inclusion criteria, 15 Declined to participate, 7 were migrants and were unable to attend for 1 month follow up. A total of 186 patients were enrolled and randomized into control and intervention groups. Male patients predominated in the study population, which had mean age 58.3 ± 12.1 years. The two groups baseline clinical and demographic features were similar demonstrating successful randomisation as shown in table 1. Most of the patients belong to the age group of 60-69 years (30.64%T, followed by 50-59 years (27.41%) and ≥ 70 years (19.35%) The least number of patients were observed in the 20-29 years age group (1.61%).

The distribution of patients by gender revealed that 115 (61.8%) of the patients were male, as compared to female. The distribution of genders in the intervention and control groups was similar.

Ischemic heart disease accounted for 62 (33.3%) of the various cardiovascular diseases, with hypertension coming in second at 50 (26.9%) patients and coronary artery disease at 32 (17.0%). Also 21 (11.3%) patients had unstable angina, 13 (7.0%) had heart failure/ left ventricular dysfunction, 11 (5.9%) had anterior wall mycardila infraction, 17 (9.1%) had type 2 DM and 7 (3.8%) had acute coronary syndrome.

The majority of patients that is 99 (53.2%), fell into pre-hypertension category according to the assessment of blood pressure categories. 57 (30.6%) had a normal blood pressure whereas 26 (14.0%) and 4 (2.2%) patients had stage 1 and stage 2 hypertension. There was a similar distribution of blood pressure categories in the intervention group and control group.

Table 1: Demographic Details and Clinical Characteristics

Variable	Category	Control (n=93)	Intervention (n=93)	Total (n=186)

Age (years)	Mean ± SD	60.6 ± 11.8	56.6 ± 12.1	58.3 ± 12.1
Age Group	20–29 years	1 (1.07%)	2 (2.15%)	3 (1.61%)
	30–39 years	4 (4.30%)	6 (6.45%)	10 (15.59%)
	40–49 years	12 (12.90%)	17 (18.25%)	29 (15.6%)
	50–59 years	20 (21.50%)	31 (33.33%)	51 (27.41%)
	60–69 years	30 (32.25%)	27 (29.03%)	57 (30.64%)
	≥70 years	26 (27.95%)	10 (10.75%)	36 (19.35%)
Gender	Male	58 (31.2%)	57 (30.6%)	115 (61.8%)
	Female	35 (18.8%)	36 (19.4%)	71 (38.2%)
Diagnosis	Ischemic Heart Disease (IHD)	31 (30.39%)	31 (27.93%)	62 (33.3%)
	Hypertension (HTN)	24 (23.53%)	26 (23.42%)	50 (26.9%)
	Coronary Artery Disease (CAD)	14 (13.73%)	18 (16.22%)	32 (17.2%)
	Unstable Angina (UA)	10 (9.80%)	11 (9.91%)	21 (11.3%)
	Type 2 Diabetes Mellitus (T2DM/DM)	8 (7.84%)	9 (8.11%)	17 (9.1%)
	Acute Coronary Syndrome (ACS)	3 (2.94%)	4 (3.61%)	07(3.8%)
	Anterior Wall MI (AWMI)	5 (4.90%)	6 (5.41%)	11 (5.9%)
	Heart Failure / LV Dysfunction	7 (6.87%)	6 (5.41%)	13 (7.0%)
Blood Pressure Category	Normal (SBP <120 and DBP <80)	28 (15.1%)	29 (15.6%)	57 (30.6%)
	Pre-hypertension (SBP 120–139 and/or DBP 80–89)	50 (26.9%)	49 (26.3%)	99 (53.2%)
	Stage 1 Hypertension (SBP 140–159 and/or DBP 90–99)	13 (7.0%)	13 (7.0%)	26 (14.0%)
	Stage 2 Hypertension (SBP ≥160 and/or DBP ≥100)	02 (1.1%)	02 (1.1%)	4 (2.2%)

Table 2 shows that the proportion of participants in each stage of hypertension in control and intervention group at baseline and follow-up. The majority of patients 50 (53.7%) control group and intervention group 49 (52.6%) were in the pre-hypertension stage at baseline. 28 (30.1%) patients in the control group and 29 (31.2%) patients in the intervention group had normal blood pressure. In both the groups that is in stage 1 hypertension it was 13 (14.0%) and stage 2 hypertension had 2 (2.2%).

The control group showed a slight improvement in blood pressure at follow up with the normal blood pressure participants rising from 30.1% to 32.3%. The proportion of patients with pre-hypertension and stage 1 hypertension slightly decreased to 50.5% and 12.9% respectively. Stage 2 hypertension increased slightly from 2.2% to 4.3%.

Following a clinical pharmacist-led intervention, the intervention group showed a more significant improvement in blood pressure management. Similarly, the percentage of patients in the pre-hypertension category decreased from 52.6% to 45.1%. Stage 1 hypertension showed a substantial reduction from 14.0% to 5.4% while stage 2 hypertension decreased from 2.2% to 1.1%.

Table 2: Measurement of Blood Pressure in Control and Intervention group

Blood Pressure Category	**BP Range (mm Hg)**	**Control N=93**		**Intervention N=93**	
		Baseline	**Follow-up**	**Baseline**	**Follow-up**

Normal	SBP <120 and DBP <80	28 (30.1 %)	30 (32.3 %)	29 (31.2 %)	45 (48.4 %)
Pre-hypertension	SBP 120–139 and/or DBP 80–89	50 (53.7 %)	47 (50.5 %)	49 (52.6 %)	42 (45.1 %)
Stage 1 Hypertension	SBP 140–159 and/or DBP 90–99	13 (14.0 %)	12 (12.9 %)	13 (14.0 %)	05 (5.4 %)
Stage 2 Hypertension	SBP ≥160 and/or DBP ≥100	02 (2.2%)	4 (4.3 %)	02 (2.2%)	01 (1.1 %)

In both groups, drug related problems (DRPs) were more commonly noted. Drug use without indication was the most prevalent DRPs, followed by indication without drug. Subtherapeutic dosage, medicine-drug interactions and ADR responses were additional problems.

Table 3: Comparison of Drug Related Problems in Both Groups

SI NO.	QUESTIONNARIES	CONTROL GROUP N (%)	INTERVENTIONAL GROUP N (%)
01.	Drug use without indication	15 (48.39%)	24 (57.14%)
02.	Indication without drug	06 (19.35%)	09 (21.43%)
03.	Inappropriate dosage form	01 (3.23%)	-
04.	Overdose	-	06 (14.29%)
05.	Sub-therapeutic dose	03 (9.68%)	02 (4.76%)
06.	Adverse drug reactions	02 (6.45%)	-
07.	Drug-drug interactions	04 (12.90%)	01 (2.38%)
08.	Failure to receive therapy	-	-
	Total	31 (100%)	42 (100%)

The assessment of drug-related problems (DRPs) identified a total of 31 DRPs in the control group and 42 DRPs in the intervention group at baseline. The most common DRP in both groups was drug usage without indication, which accounted for 57.14% in the interventional group and 48.39% in the control group.

The second most common DRP identified was indication without drug, observed in 19.35% of cases in the control group and 21.43% in the interventional group indicating gaps in appropriate pharmacotherapy where required medications were not prescribed.

Drug-drug interactions accounted for 12.90% in the control group and 2.38% in interventional group. Sub-therapeutic dose was also recorded in both the groups (4.76% in the intervention group and 9.68% in the control group), indicating instances of insufficient dosing that could compromise therapeutic outcomes.

Overdose was identified exclusively in the intervention group about 14.29%, while inappropriate dosage form about 3.32% and adverse drug reactions that is about 6.45% were observed only in control group. There were no cases of failure to receive therapy were reported in either group.

Table 4: Resolved drug-related problems in intervention group

SI.No	DRP Category	DRP Description
01.	Drug Use Without Indication	1. T. mucomix (acetylcysteine) Patient was diagnosed with CAD-TVD, Hypothyroidism, CKD, Hypertension. 2. Cap. Abflo (acebrophylline) Patient was diagnosed with acute LVF, CKD, Hypothyroidism, and Hyprtension. 3. Inj. Xone (ceftriaxone) 1gm 1-0-1 IHD, Hypertension. 4. T. trika (alprazolam) 0.25mg 0-0-1 Patient was diagnosed with IHD and Hypertension. 5. T. lobun (glimepiride, metf) 4/500mg 1-0-0 Patient was diagnosed with IHD and Hypertension. 6. Paracetamol (acetaminophen) 650mg s-o-s No complaints of any inflammation or fever. 7. T. camerol sr (estradiol) 90mg 0-0-1 Patient was diagnosed with IHD AWMI

		8. T. Tamsan (tamsulesin) 40mg 1-0-0 Patient was diagnosed with RHD. 9. Inj. Hatrazon (diethylcarbamazine citrate) 100mg 1-1-1 Patient was diagnosed with RHD. 10. T orni (ofloxacin and ornidazole) 50mg ½-0-½ 11. T. nabicord (nebivolol) 5mg 1-0-0 12. T. ondero (linagliptin) 5mg 1-0-0 Patient was diagnosed with CAD-DVD, ACS and Primary Hypertension, no complaints of diabetes mellitus was reported. 13. T. linid (linezolid) 600mg 1-0-1 Patient was diagnosed with CAD-DVD, ACS and Primary Hypertension, no complaints of any bacterial infection was reported. 14. T. pentid (penicillin G) 400mg 1-0-1 Patient was diagnosed with RHD, and primary hypertension. 15. T. seridon (acetaminophen) 50mg 0-1-0 No complaint of headache or body ache was seen in patient and patient was diagnosed with IHD. 16. Inj. Xone (ceftriaxone) 1mg 1-0-1 Patient was diagnosed with IHD, CAD-TVD and hypertension. 17. T. lizomac (linezolid) 5mg 1-0-0 Patient was diagnosed with CKD and hypertension there was no need for anti-biotics. 18. T. cudce 100mg 1-1-1 Patient was diagnosed with CKD and hypertension there was no need for anti-biotics. 19. T. tamsulocin(tamsulosin hydrochloride) 40mg 1-0-0 Patient was diagnosed with hypertension. 20. Inj. Xone (ceftriaxone) 1mg 1-0-1 Patient was diagnosed with IHD, CAD-TVD and hypertension. 21. T. deriphylline 300mg 0-1-0 Patient was diagnosed with IHD, type 2 DM and Hypertension. 22. T. levidine(levetiracetam) 500mg 1-0-1 Patient was diagnosed with tachycardia and bradycardia. 23. T. Levipil(levetiracetam) 750mg 1-0-1 Patient was diagnosed with IHD and Hypertension. 24. T. abflo (acebrophylline and N-acetylcysteine)100mg 1-0-1 Patient was diagnosed with ACS AWMI and hypertension.
02.	Indication Without Drug	1. Patient is diagnosed with diabetes mellitus and seen with no medications. 2. Patient was suffering from deep vein thrombosis and there was no medical plan for management. 3. Patient was diagnosed with Diabetes mellitus and no medical treatment was given to treat DM. 4. No medication for management of Diabetes mellitus. 5. Patient was diagnosed with type 2 Diabetes

		mellitus where no treatment was given for management. 6. Medication for emphysema was not prescribed. 7. Patient was diagnosed with COPD. 8. SC emphysema was diagnosed during the visit, but no treatment was given. 9. Patient was diagnosed with CAD-SVD, ACS-AWMI, DM and hypertension but there was no treatment given for control dm.
03.	Inappropriate Dosage Form	----
04.	Overdose	1. Acetylcysteine (600mg) 1-0-1 • Drug was prescribed twice a day, but maximum dose for acetylcysteine in adult is 600mg. 2. Enoxaparin (60mg) 1-0-1 • Maximum dose for the drug is 100mg/day. 3. Cefotaxime (2gm) 1-1-1 • Maximum daily dose for drug is 4gm/day. 4. Inj. Taxim (2gm) 1-1-1 • Maximum dose is 4gm per day 5. Voglibose (0.3mg), glimepiride, metformin (4/500mg)1-0-1 • Combination of three anti-diabetic is not required in the patient. 6. Telmisartan (40mg) 1-0-1
05.	Sub-Therapeutic Dose	1. Dytor plus (torsemide and spironolactone) 10mg/50mg ½-0-0 • The patient required at least one tablet per day instead of half tablet. 2. Atorvastatin (10mg) 0-0-1 • The patient requires minimum of 20 mg of atorvastatin.
06.	Adverse Drug Reaction	----
07.	Drug-Drug Interactions	1. Heparin with aspirin caused bleeding.
08.	Failure to Receive Therapy	----

The detailed analysis of management model for drug related problems showed that drug use without indication was the most frequently identified and was common issue, with several medications such as antibiotics, mucolytics, antidiabetics and CNS drugs were prescribed without appropriate clinical justification, particularly in patients with cardiovascular conditions. Indication without drug therapy was mainly observed in patients with diabetes mellitus, COPD, Deep vein thrombosis and liver dysfunction. Inappropriate dosage form was rarely reported. Overdose-related problems combinations, while sub-therapeutic dosing was observed with diuretics, anticoagulants and antiplatelet agents. Only minimal adverse drug reactions were reported, while drug-drug interactions, particularly among cardiovascular drugs, posed risks such as bleeding and toxicity and clinically significant drug-drug interactions were also identified whereas no cases of failure to receive therapy were documented.

Table 5: Hill-Bone Scale For High Blood Pressure Compliance

Sl. No.	Questionnaires	Control				Intervention			
		None of the time	Some of the time	Most of the time	All of the time	None of the time	Some of the time	Most of the time	All of the time
1.	How often do you forget to take your high blood pressure med	71 (76.34%)	20 (21.51%)	02 (2.15%)	0 (0.00%)	79 (84.95%)	14 (15.05%)	0 (0.00%)	0 (0.00%)

	icine?								
2.	How often do you decide not to take your high blood pressure medicine?	75 (80.65 %)	16 (17.20 %)	02 (2.15 %)	0 (0.00 %)	76 (81.72 %)	17 (18.28 %)	0 (0.00 %)	0 (0.00 %)
3.	How often do you miss taking your high blood pressure medicine when you feel better?	77 (82.80 %)	16 (17.20 %)	0 (0.00 %)	0 (0.00 %)	73 (78.49 %)	19 (20.43 %)	1 (1.08 %)	0 (0.00 %)
4.	How often do you miss taking your high blood pressure medicine when you feel sick?	72 (77.42 %)	18 (19.35 %)	3 (3.23 %)	0 (0.00 %)	77 (82.80 %)	15 (16.13 %)	1 (1.08 %)	0 (0.00 %)
5.	How often do you take your high blood pressure medicine more than once a day?	72 (77.42 %)	21 (22.58)	0 (0.00 %)	0 (0.00 %)	78 (83.87 %)	14 (15.05 %)	1 () 1.08 %	0 (0.00 %)
6.	How often do you forget to bring your medicine with you when you travel?	60 (64.52 %)	21 (22.58 %)	6 (6.45 %)	6 (6.45 %)	67 (72.04 %)	21 (22.58 %)	3 (3.23 %)	2 (2.15 %)

7.	How often do you eat salty food?	26 (27.96 %)	64 (68.82 %)	3 (3.23 %)	0 (0.00 %)	26 (27.69 %)	67 (72.04 %)	0 (0.00 %)	0 (0.00 %)
8.	How often do you add salt to your food at the table?	64 (68.82 %)	29 (31.18 %)	0 (0.00 %)	0 (0.00 %)	66 (70.97 %)	26 (27.69 %)	1 (1.08 %)	0 (0.00 %)
9.	How often do you eat fast food?	24 (25.81 %)	44 (47.31 %)	25 (26.88 %)	0 (0.00 %)	22 (23.66 %)	53 (56.99 %)	18 (19.35 %)	0 (0.00 %)
10.	How often do you miss your appointment with your healthcare provider?	80 (86.02 %)	12 (12.90 %)	1 (1.08 %)	0 (0.00 %)	80 (86.02 %)	12 (12.90)	0 (0.00 %)	1 (1.08 %)
11.	How often do you arrive late for your appointment?	46 (49.46 %)	46 (49.46 %)	1 (1.08 %)	0 (0.00 %)	50 (53.76 %)	42 (45.16 %)	0 (0.00 %)	1 (1.08 %)
12.	How often do you leave your appointment before being told?	79 (84.95 %)	14 (15.05 %)	0 (0.00 %)	0 (0.00 %)	78 (83.87 %)	15 (16.13 %)	0 (0.00 %)	0 (0.00 %)
13.	How often do you cancel or reschedule your appointment?	65 (69.89 %)	27 (29.03 %)	1 (1.08 %)	0 (0.00 %)	71 (76.34 %)	22 (23.66 %)	0 (0.00 %)	0 (0.00 %)

This hill-bone scale results explain us that patients in both the control and intervention groups showed generally good adherence, according to the baseline assessment of medication adherence and lifestyle modification- related behaviours using the hill-bone scale. In control group about 76.34% and in intervention group about 84.95% where majority patients in both groups reported that they never forget to take their anti-hypertensive medications, demonstrating comparatively excellent baseline adherence. Whereas most participants reported that

they did not intentionally skip their medications, with over 80%.

In terms of behaviour during symptomatic changes, a significant percentage of patients in both the groups reported that they tool their medications on time regardless of how they felt about their symptoms. However, a small percentage of patients in both groups still reported occasional lapses, particularly when they feel sick, suggesting a possible area for focused interventional group.

Regarding medication taking habits of patients, the majority of patients stated that they did not take their prescribed drugs in excess, indicating proper adherence to dosage schedules. However, a significant percentage of patients especially in the control group reported forgetting to bring their medications when they faced with practical obstacles like travel, indicating a gap in adherence due to living circumstances.

Dietary habits revealed moderate adherence to recommended practices. Few patients reported eating salty foods frequently, but most reported eating them relatively infrequently. Furthermore, the majority of patients reported not adding extra salt at the table which is encouraging when it comes to managing hypertension. Fast food consumption, however was relatively common with a considerable proportion of patients reporting intake Some of the time or most of the time, suggesting the need for dietary counselling.

Appointment adherence was generally good across both the groups. Most patients reported that they did not miss their healthcare appointments, and only a small fraction was reported frequently. However, almost half of the patients in both the groups reported being late for visits Some of the time, suggesting that punctuality was a problem.

In addition, relatively few patients reported often cancelling or rescheduling visited or leaving appointments early, suggesting generally positive patients engagement with healthcare services. The distribution of responses across both the groups was comparable at baseline, suggesting that the randomization process was effective and that both the groups were similar prior to the interventional group.

In general, the results show that even though baseline adherence and healthcare engagement were comparatively high, some behavioural gaps persisted and could be addressed by structured clinical pharmacist-led interventions. Here gaps include forgetting medications while travelling and following less-than ideal eating habits.

Table 6: Pre and Post Intervention Hill-Bone Adherence Scores (N=186)

Parameter	Control group (Mean ± SD)	Intervention group (Mean ± SD)	p-value
Medication Taking Subscale	19.1 ± 4.3	16.2 ± 3.6	<0.001
Salt Intake Subscale	9.9 ± 2.5	8.1 ± 2.2	<0.001
Appointment Keeping Subscale	7.5 ± 2.0	6.2 ± 1.9	0.002
Total Hill-Bone Score	**36.5 ± 6.1**	**30.5 ± 5.3**	**<0.001**

The comparison of Hill-bone adherence scores showed a significant improvement in the intervention group compared to the control group. The medication taking subscale score was lower in the intervention group about 16.2 ± 3.6 and then in the control group that is 19.1 ± 4.3, indicating better adherence ($p<0.05$). Similarly the salt intake subscale and appointment keeping subscale scores were also significantly lower in the intervention group that is about 8.1 ± 2.2 and 6.2 ± 1.9 as compared to the control group 9.9 ± 2.5 and 7.5 ± 2.0 respectively.

The total Hill-Bone score was significantly in the intervention group about 30.5 ± 5.3 as compared to the control group about 36.5 ± 6.1, demonstrating overall improved adherence following interventions.

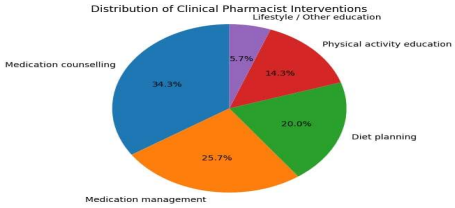

Figure 2: Distribution of clinical pharmacist–led interventions among cardiovascular disease patients.

Only a small percentage of patients reported pre-existing conditions such as diabetes mellitus, hypertension, ischemic heart disease, thyroid disorders or a combination of diabetes and thyroid disease. These conditions are well-established contributors to cardiovascular disease development and progression. The comparatively low prevalence of documented comorbidities in past medical history, despite their frequent presence in provisional diagnosed during the current hospital visit. This emphasizes the importance of comprehensive evaluation at the time of admission and highlights gaps in prior disease detection and long-term disease management.

DISCUSSION:

The present randomised controlled study evaluated the impact of a clinical pharmacist-led management model on medication adherence and clinical outcomes among patients with cardiovascular disease.

The current study showed that after clinical pharmacist-led management, the intervention groups blood pressure was improved. At follow-up the percentage of patients in the intervention group with normal blood pressure increased significantly from 31.2% to 48.4% while the patients in stage 1 and stage 2 hypertension categories decreased. Together, the control group showed very sightly improvement. These results suggested that pharmacist-led treatments, such as medication reviews, patient counselling and adherence to medication may improve cardiovascular outcomes and hypertension management. Similar findings were reported by Moura L et al. and Talasaz AH who focused positive impact of clinical pharmacist role in management of cardiovascular care and blood pressure control. [1,2]

Drug-related problems were frequently identified at baseline in both groups, highlighting the complexity of pharmacotherapy in cardiovascular patients who often require multiple medication for comorbidities. Identifying such DRPs emphasizes the need for structured medication review in routine clinical practice. However, following clinical pharmacist intervention several identified DRPs were resolved through medication review, dose optimization, therapeutic substitution and communication with physicians.

The study finds that there was significant improvement in medication adherence in interventional group as assessed by the Hill-Bone adherence scale, following clinical pharmacist intervention there was a marked reduction in non-adherence behaviours specifically, improvements were noted as

- Reduced frequency of forgetting antihypertensive medications.
- Reduced intentional skipping of doses.
- Better appointment adherence.
- Improve dietary compliance (salt restriction and reduced fast-food intake).

As compared to control group receiving standard care did not demonstrate comparable improvement. The observed difference between the groups was statistically significant ($p<0.05$), confirming the effectiveness of pharmacist-led interventions.

Overall, the intervention group demonstrated better improvement in blood pressure control compared to the control group, suggesting the positive impact of clinical pharmacist-led management on hypertension outcomes among cardiovascular disease patients.

Pharmacist plays important role in optimising drug therapy outcomes through patient education, medication review and medication adherence support. This study was compared with the study of Moura et al. where they demonstrated that structured cardiovascular training enhances pharmacist ability to deliver effective clinical care in primary settings [1]. Likewise, talasaz focused on the potential of clinical pharmacy services in improving outcomes among cardiovascular patients [2] whereas pounds and Lyekegbe emphasized the pharmacist's role in patients counselling and disease management [3].

The improvement in medication adherence observed in this study is supported by linking adherence to reduced cardiovascular risk. Lithovius et al. reported that adherence to cardioprotective medications is associated with a lower incidence of cardiovascular complications in patients with diabetes [8]. Analogously, Wake et al. demonstrated patterns of adherence and persistence with lipid-lowering therapy in high-risk populations [10].

Structured interventions were also have been shown that to enhance the adherence. McAlister et al. showed that adherence to cardiovascular medications remained stable during COVID-19 pandemic, emphasizing the importance of continuity of patients care [12]. A systematic review and meta-analysis by Gebremichael et al. demonstrated that cardiac rehabilitation programs significantly improve medication adherence [9].

The global burden of cardiovascular disease continues to rise. Here the global burden disease study highlights the increasing prevalence and impact of cardiovascular disease across regions, particularly in low and middle-income countries [4]. In India, significant gaps exit in the hypertension awareness, treatment and control as demonstrated by Priti et al. [14]. Thus, these types of gaps here underscore the need for accessibility and effectiveness of interventions.

High risk factors such as sleep disturbances and metabolic further contributes to cardiovascular disease progression. Yan et al. reported that an association between sleeping patterns and risk of developing hypertension with cardiovascular disease [5]. Corresponding to Guo et al. identified the relationship between insulin resistance and hypertension [15], whereas Cheddani et al. developed the predictive models for management of hypertension [16]. These results highlight the significance of throughout risk management which was included in the study's intervention.

The current understanding of hypertension is a major contribution for cardiovascular morbidity and mortality. Ahn et al. demonstrated its impact on mortality in myocardial infraction patients [22], while soros et al. stated its role in long-term neurological complications such as dementia [17]. Therefor controlling blood pressure effectively is essential to lowering the overall burden of disease.

By using multi model approach to improve therapy adherence, optimal blood pressure targets can be attainted. In order to identify confounding factors that could negatively impact on adherence, family doctors,

specialty consultants, pharmacists and others allied health professionals need to improve how they treat individuals with hypertension and find potential simplification strategies for routine medication regimen reviews. They must inform and counsel patients on the value of taking their prescriptions as prescribed, prevent medication shortages and use technology-based medication assistance.

CONCLUSION:

Clinical pharmacist-led management significantly improved medication adherence contributes to clinical outcomes in patients with cardiovascular disease. Incorporating clinical pharmacists into the multidisciplinary care teams can enhance the therapeutic effectiveness, promote rational drug use and optimize overall patient care.

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ETHICAL APPROVAL:

The study was conducted in accordance with the ethical principles outlines in the declaration of Helsinki. Ethical approval for this randomized clinical trial was obtained from the institutional ethics committee (IEC) of the KLEs Dr. Prabhakar Kore hospital and medical research centre prior to the initiation of the study. The study protocol was reviewed and approved by the Institutional Ethics Committee of KLEs Dr. Prabhakar Kore Hospital and Medical Research Centre. (Ref. No.: KLECOPBGMEC/D009-2025) dated 20th August 2025.

AUTHORS CONTRIBUTIONS:

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by SNB. The first draft of the manuscript was written by SNB and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

DATA AVAILABILITY STATEMENT:

Due to ethical restrictions, patient confidentiality and privacy has to be maintained, the data should not be publicly available.

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