RESEARCH PAPER

Effectiveness of prescribed step-up PSEP program upon functional status among patients undergoing CABG surgery at selected hospitals, Chennai.

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ABSTRACT

Many patients undergoing coronary artery bypass grafting (CABG) struggle with recovery, including issues like low oxygen levels, breathlessness, and limited independence. Physical activity training after surgery can help improve recovery and prevent complications. This study tested the effect of a prescribed Step-Up Exercise Program (PSEP) on the functional recovery of 160 CABG patients. The results showed significant improvements in oxygen levels, breathlessness, and independence in the PSEP group compared to the control group. The study supports the use of PSEP to enhance recovery after CABG surgery. The advancement to knowledge in this research is the demonstration that the Prescribed Step-Up Exercise Program (PSEP) significantly improves functional recovery, oxygen saturation, and reduces shortness of breath in patients recovering from Coronary Artery Bypass Grafting (CABG) surgery, offering a targeted rehabilitation approach for post-operative care

Keywords: Coronary artery bypass grafting, Prescribed step-up program, Functional Status & Post-operative

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INTRODUCTION

The global community has set an ambitious target to reduce premature death from non-communicable diseases (NCDs) by 35% by 2025 compared to 2015 levels. However, achieving this goal appears challenging, especially with the rising prevalence of cardiovascular diseases worldwide **[1]**. Coronary artery bypass grafting (CABG) has emerged as a highly effective treatment for multi-vessel coronary artery disease, as well as one- or two-vessel disease, particularly when percutaneous coronary intervention (PCI) is contraindicated or fails **[2]**. Over the years, the number of CABG procedures performed globally has been steadily increasing, and these surgeries are now being conducted more frequently on older patients who often suffer from multiple comorbidities and are physically unfit. This demographic shift has led to an increased need for rehabilitation programs tailored to their specific medical needs **[3]**. Consequently, there is a pressing need to reassess existing rehabilitation strategies and develop new programs designed to accommodate patients who are at a higher risk of postoperative complications. Physical activity has long been recognized as a key component of rehabilitation in various clinical settings, including ischemic heart disease and cardiac surgery. One of the most widely used tools to assess a patient's functional capacity is the 6-minute walk test (6MWT), initially introduced by pulmonologists to evaluate patients with chronic obstructive pulmonary disease (COPD) and respiratory failure **[4]**. Over time, the 6MWT gained recognition for its effectiveness in assessing functional limitations and rehabilitation progress in patients with chronic heart failure. Although the 6MWT has been predominantly used for assessing the physical condition of patients with severe cardiopulmonary diseases, its application in cardiac rehabilitation remains somewhat underexplored **[5]**.

The 6MWT is a simple, cost-effective, and low-tech method to evaluate a patient's functional capacity. The test involves asking patients to walk for six minutes at their own pace, and the maximum distance they cover is used as an indicator of their physical ability **[6]**. This test has become an independent post-surgical recovery tool, helping clinicians assess the impact of various treatments on patients' functional status after CABG. Numerous studies have demonstrated that the 6MWT is critical in predicting the risk of hospitalization and mortality among cardiovascular patients, particularly those with heart failure and low left ventricular ejection fraction. Research has also shown that it is a reliable tool for assessing patients with heart failure and preserved left ventricular diastolic function **[7]**. One of the key advantages of the 6MWT is its practicality. It requires minimal equipment and is well-tolerated by most patients, including older and frail individuals. For patients who cannot undergo more strenuous exercise tests, such as those who have recently undergone major surgery, the 6MWT provides an alternative means of evaluating

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functional capacity **[8]**. CABG patients, in particular, face a high risk of developing postoperative complications that can lead to extended hospital stays and increased healthcare costs. Therefore, assessing their functional capacity during the recovery phase is crucial to address any potential decline in their physical activity post-surgery **[9]**. Walking, being the most common form of daily physical activity is often recommended to improve physical fitness; however, its inclusion in rehabilitation guidelines has been limited. The objective evaluation of this type of exercise remains a challenge, but the 6MWT offers an effective solution to this problem **[10]**. Given its simplicity, safety, and the direct insights it provides into a patient's functional capacity, the 6MWT has become one of the most important tests in clinical practice for evaluating exercise capacity in patients with coronary artery disease **[11]**. This study was conducted to evaluate the effectiveness of the Prescribed Step-Up Exercise Program (PSEP) in improving the functional status of patients undergoing CABG surgery. By focusing on enhancing physical capacity and preventing cardiopulmonary complications, the study aims to provide a more targeted approach to post-surgery rehabilitation. Therefore, this study is important to determine the effectiveness of the Prescribed Step-Up Exercise Program in improving the recovery and functional outcomes of CABG patients, helping to guide future rehabilitation strategies for this growing patient population.

METHODS AND MATERIALS:

A non-randomized interventional study was conducted at the post-operative cardiac units of the selected two tertiary care centers from January 2024 to March 2024. Ethical clearance was obtained from the institutional ethics committee. The sample size was estimated based on the study findings of Mansour et al., using OpenEpi version 3 with Spo2 mean score values of 95.2± 1.7 (experimental group) and 92.90± 3.18 (control group), 95% -power and 99.9% -Confidence Interval).[18] The required sample size for each group was 76**.** However, considering the attrition and for better generalization, 160 participants (**80 in each group**) were included in the study. The samples were selected consecutively from both the centers based on eligibility criteria. The study population included patients who were undergoing Coronary artery bypass grafting surgery, available at the time of data collection and willing to participate in the study. Patients with orthopedic conditions that would prohibit walking, who had severe visual & hearing problem, physically challenged & major health problem, <EF 35% before surgery, patients with combined coronary artery bypass grafting and valve surgery and patients who cannot comprehend to cooperate for the study were all excluded from the study. However, there was attrition in both the groups and finally 160 coronary artery bypass grafting patients (80 in PSEP group and 80 control group) were included in the analysis.

The purpose of the study was explained to the patients and informed consent was obtained from each study participant. All guidelines as per declaration of Helsinki and good clinical practice guidelines were followed. A total number of 160 samples (80 samples from each setting) were selected by using consecutive sampling technique from both the settings. A non -randomized quasi experimental design was adopted for this study. The baseline data on background variables, clinical variables and functional status were assessed on 3rd post -operative day in both the groups. Then the deep breathing and six minute walking exercise were administered to the PSEP group for a period of 5 days from 3rd to 7th postoperative day. They were advised to perform breathing exercises from morning to night for 7 days, every three hours; each session 3 sets of breathing exercise was performed (10 deep breaths per set with a few seconds pause between each set). Then they were made to walk on a flat hard surface for a period of 6 minutes, once a day for 6 days a week and the distance walked by them was measured each day [3rd postoperative day to 7thday].While walking the patients were assisted by the researcher and encouraged through positive reinforcement and also provided feedback of their performance. The patients in the control group were given standard post-operative care. The posttest I and II were done on 3rd and 7th postoperative day by assessing functional status after the prescribed step up PSEP program and standard care. Confidentiality was maintained throughout the procedure. The collected data was analyzed using SPSS 22. The descriptive statistics like frequency, percentage distribution, mean and standard deviation were used to describe the data and inferential statistics such as chi square and independent t test to check the homogeneity of the study participants in both the group, Repeated measures ANOVA to compare pretest & posttest scores of SPO_2, dyspnea, FIM and anxiety, independent 't' test to compare the scores between the groups were used.

RESULTS:

The distribution of background characteristics of the CABG patients in control and PSEP group of this (**Table 1**) study revealed that majority of patients admitted for CABG were aged between 51 and 65 years (58.75& 57.57%), males (96.3% & 100%), married (88.8% & 96.3%), urban residents, (81.3% & 62.5%) and graduates (66.3 % & 62.5%). About 47.5% of the patients were employed in organized sectors in both groups, and 75% & 82.5% were classified as sedentary workers. Furthermore, 50 % & 47.5% reported a family monthly income exceeding Rs 50,000-1000000 with 42% &58.8% experiencing mild stress and 63.8% and 50% receiving good social support, half of the participants were non-vegetarians (57% and 52%), current smokers (58% and 43%) with the BMI exceeding 25 (45% and 43.8%), furthermore, the ability to walk at a pace of less than 2 miles per hour preoperatively was observed in 58.8% and 56.3% of the patients and the daily consumption of alcohol was reported by 47.5% and 45%, presence of comorbid illnesses (hypertension) was observed in 32.5% and 43.8% of them, while the ejection fraction ranged 50% - 75% among 51.3% and 48.8% of patients. Additionally, saphenous vein and LIMA grafts were used in 43% and 70% of patients with double vessel disease occurrences of 58.8% and 56.3% in control and the

PSEP group respectively as in T**able 2**. There was also no significant difference in baseline pre-surgical bio-physiological variables such as systolic and diastolic blood pressure and heart rate (**Table 3**). Hence the above results indicate the homogeneity of both the group.

The repeated measures ANOVA results (**Table 4**) showed significant changes in SPO_2, walking shortness of breath and functional independence measure ($p < 0.001$) in both control and PSEP group. But the difference between pretest, posttest I & posttest II SPO_2, shortness of breath and functional independence measure in the PSEP group was comparatively higher than those of control group. The independent t test revealed that in the pretest scores of SpO_2, shortness of breath and functional independence measure between the control group and PSEP group were similar ($p>0.05$) whereas, there was a difference in the posttest scores of SpO_2, shortness of breath and functional independence measure in the PSEP group than those of control group which was statistically significant at $p<0.001$.The findings showed a significant variation among the two groups regarding the oxygen saturation pre and post 6MWT. **Table 1** presents the frequency and percentage distribution of socio-demographic variables of patients undergoing coronary artery bypass graft (CABG) surgery in the control and intervention groups. The table displays demographic variables such as age, gender, marital status, educational qualification, occupation, nature of work, monthly family income, residence, perceived stress, and perceived social support. **Table 2** shows the frequency and percentage distribution of lifestyle and clinical variables of patients undergoing CABG surgery in the control and intervention groups. This includes variables such as body mass index (BMI), resistance speed, diet pattern, exercise habits, smoking, alcohol intake, comorbidities, disease type, types of graft, and pre-operative echocardiogram results. **Table 3** compares the mean and standard deviation of bio-physiological measures in the control and intervention groups. It includes measurements of blood pressure (systolic and diastolic) and heart rate (pre-surgical and pre-test values). **Table 4** presents the comparison of pretest and posttest functional status (SpO2, shortness of breath, and FIM) and anxiety among patients undergoing CABG surgery between the control and intervention groups. This table details the mean differences, t-values, and p-values for various assessments at pretest, post-test 1, and post-test 2.

Table 5 presents the frequency and percentage distribution of co-morbidities, disease types, graft types, and pre-operative echocardiogram results in the control and intervention groups. It includes data on hypertension, diabetes mellitus, single, double, and triple vessel diseases, types of grafts (saphenous vein, left IMA, right IMA), and pre-operative ejection fraction categories.

Table 1: Frequency and percentage distribution of socio-demographic variables of patients undergoing cabg surgery in the control and intervention group.(N=160)

Demographic Variables	Control Group (n=80)		Intervention Group (n=80)		Chi - Square df & 'p' value
	F	%	F	%	
Age in years					0.74 df =2 0.68
31 – 50	17	21.25	14	17.5	
51 – 65	47	58.75	46	57.5	
66 and above	16	20	20	25	
Gender					NA
Male	77	96.3	80	100.0	
Female	3	3.8	00	00	
Marital status					3.24 df =1 0.07
Married	71	88.8	77	96.3	
Single	9	11.3	3	3.8	
Educational Qualification					1.285 df 3 0.732
No formal education	12	15.0	10	12.5	
Primary & Secondary	6	7.5	9	11.25	
Higher Secondary/ PUC	9	11.3	11	13.75	
Graduate and Above	53	66.3	50	62.5	
Occupation					3.52 df= 4 0.47
Unemployed	9	11.3	04	05.0	
Employed in organized sector	38	47.5	38	47.5	
Employed in unorganized sector	20	25.0	18	22.5	
Self employed	10	12.5	15	18.8	
Retired	3	3.8	5	6.3	
Nature of work					1.35 df =2 0.25
Sedentary work	60	75.0	66	82.5	
Moderate work	20	25.0	14	17.5	
Heavy work	-	-	-	-	
Monthly Family Income (INR)					0.59 df= 2 0.74
≤ 50000	33	41.3	32	40	
50001 to 100000	40	50	38	47.5	
Above 100000	7	8.75	10	12.5	

Residence					0.08 df=1 0.76
Urban	55	81.3	50	62.5	
Semi urban/ Rural	25	18.8	30	37.5	
Perceived stress					
Nil	12	15.0	12	15.0	5.16 df=3 0.08
Mild stress	34	42.5	47	58.8	
Moderate stress	34	42.5	21	26.3	
Severe stress	12	15.0	12	15.0	
Perceived social support					3.08 df=2 0.08
Good	51	63.8	40	50.0	
Average	29	36.3	40	50.0	
No support	--	-	-	-	

Table 2: Frequency and percentage distribution of life style and clinical variables of patients undergoing cabg surgery in the control and intervention group N=160

Life Style Variables	Control Group (n=80)		Intervention Group (n=80)		Chi-Square, df 'p' value
	F	%	f	%	
Body Mass Index (Kg/m2)					0.03 df=2 0.98
Normal (18.5 - 23)	19	23.8	19	23.8	
Overweight (23.1 - 25)	25	31.3	26	32.5	
Obesity (> 25)	36	45.0	35	43.8	
Resistance Speed (Walking)					0.10 df=1 0.75
≤2 miles /hr	47	58.8	45	56.3	
<4 miles/hr	33	41.3	35	43.8	
Diet pattern					0.40 df=1 0.52
Vegetarian	46	57.5	42	52.5	
Non-vegetarian	34	42.5	38	47.5	
Exercises					0.54 df=2 0.76
Walking/ Jogging	52	65	56	70	
Gym	22	27.5	18	22.5	
Yoga	6	7.5	6	7.5	
Nil	-	-	-	-	
Smoking habit					
Current smoker	47	58.8	35	43.8	4.36 df=2 0.11
Ex-smoker	23	28.8	27	33.8	
Non-smoker	10	12.5	18	22.5	
Alcohol intake					1.61 df=2 0.66
Daily	38	47.5	36	45.0	
Weekly	19	23.8	21	26.3	
Occasionally	12	15.0	16	20.0	
Never	11	13.8	7	8.8	

Table 3: Mean and standard deviation of bio-physiological measures of control and intervention Group (N=160)

Bio physiological Measures	Control Group (n=80)		Intervention Group (n=80)		't' value	'p' value
	Mean	SD	Mean	SD		
Blood Pressure						
Pre-surgical Systolic BP	123.13	9.04	121.45	9.51	1.14	0.26
Pre-surgical Diastolic BP	79.90	7.00	79.3	6.67	0.56	0.58
Pre-test Systolic BP	123.45	9.40	122.63	9.98	0.54	0.59
Pre-test Diastolic BP	80.35	7.51	79.5	6.93	0.74	0.46
Heart Rate						
Pre-surgical HR	85.95	10.51	85.08	10.82	0.52	0.60
Pre-test HR	84.58	8.47	81.25	8.71	2.45	0.01

Table 4: Comparison of Pretest and Post -test Functional Status (SpO_2, Shortness of Breath & FIM) & Anxiety among patients undergoing CABG surgery between the Control and Intervention Group (N=160)

Functional Status	Control group (n=80)		Intervention group (n=80)		Mean Diff	't' value	'p' value
	Mean	SD	Mean	SD			
Spo2							
Pre test	89.95	2.18	89.98	2.05	-0.025	0.075	0.94
Post-test 1	90.28	2.42	90.25	2.19	0.03	0.07	0.95
Post test 2	90.10	2.56	97.23	1.30	-7.13	22.16	**<0.001**
F & p value							
Shortness of breath							
Pre test	2.80	1.01	2.76	0.59	0.05	0.37	0.71
Post-test 1	4.75	0.93	6.75	0.65	2.00	14.331	**<0.001**

Post-test 2	5.10	1.05	2.91	1.30	2.17	11.789	**<0.001**
F & p value							
FIM							
Pre – surgery	127.63	13.78	133.08	18.28	-5.45	-2.12	0.057
Pre test	46.70	3.95	49.03	4.10	-2.33	-3.65	**<0.001**
Post-test 1	65.33	8.88	77.28	7.89	-11.95	-8.99	**<0.001**
Post-test 2	77.70	8.45	122.00	17.34	-44.30	-20.54	**<0.001**
F & p value							
Anxiety							
Pre – surgery I	52.55	7.60	53.60	9.93	-1.05	-.751	0.45
Pre – surgery II	46.13	10.37	28.63	5.60	17.5	13.284	**<0.001**
Pre test	50.95	5.47	51.33	7.34	-0.38	-.367	0.71
Post-test 1	49.65	5.81	30.95	4.86	18.70	22.078	**<0.001**
Post-test 2	12.50	3.97	12.30	4.16	0.20	.311	0.76
F & p value							

Table 5: Co-morbidity, Disease Type, Graft Type, and Pre-operative ECHO Distribution among Patients in the Control and Intervention Groups

Co morbidity					**7.16**
Hypertension	26	32.5	35	43.8	**df=4**
Diabetes mellitus	27	33.8	21	26.3	**0.07**
Hypertension and Diabetes Mellitus	22	27.5	24	30	
Nil	5	6.3	0	0	
Others if yes specify	-	-	-	-	
Disease					0.28
Single vessel disease	10	12.5	9	11.3	df=2
Double vessel disease	47	58.8	45	56.3	0.87
Triple vessel disease	23	28.8	26	32.5	
Types of Graft					0.28
Saphenous vein graft	16	20	4	5	df=3
SVG & Left IMA	35	43.8	56	70	0.87
SVG & Right IMA	19	23.8	18	22.5	
Others	10	12.5	2	2.5	
Pre-operative ECHO					0.11
75 - 50%	41	51.3	39	48.8	df=2
49 - 36%	31	38.8	33	41.3	0.94
<35%	8	10	8	10	

DISCUSSION:

Preoperative instruction in deep breathing and walking is necessary to prevent cardiopulmonary complications after coronary artery bypass grafting (CABG). Patients who have had cardiac surgery tend to heal more quickly when they are able to exercise more; as a result, cardiac rehabilitation should be promoted to these patients once they leave the hospital **[12]**. The findings of the current study revealed that majority of patients admitted for CABG were aged between 51 and 65 years (58.75& 57.57%) in both the groups. This finding is corresponding to other research study reporting that more than two-thirds of the intervention and control groups were in the age group between 51- 65 years and were previous smokers. More than half of the intervention and control groups had normal body mass index. No significant variation was detected among the intervention and control groups concerning gender, age, and smoking status **[13]**. The present study result highlights that body mass index has a great influence in developing cardiac diseases as most of the patients were overweight. Previous study findings support this finding that the body mass ratio was found to have significant association with the development of complications after surgery. The impact of the previous history of co-morbid illness among patients in both groups may be a contributing factor for developing complications. Being overweight is a significant risk factor for predicting cardiovascular disease and is associated with co-morbid illness. With regard to the background characteristics the patients in the PSEP and control group were homogenous. The findings showed a significant variation among the two groups regarding the oxygen saturation and shortness of breath, FIM and anxiety pre and post the 6MWT. Similar findings were reported in another study that there was a greater difference in physiological parameters in their studied groups after the 6MWT **[14]**. However, this contradicts the findings of another study, which did not show significant variation in the heart rate, distance walked, blood pressure, or oxygen saturation. The findings illustrated a significant variation between the two groups only concerning the length of stay in the ICU **[15]**. Our study findings are harmonious with the results of another study which revealed that the length of ICU stay is significantly longer in the control group than in the study group It may be attributed to the 6MWT that directly measures actual walking performance, which confirms the performance commonly used in daily activities. Therefore, the 6MWT can achieve quick recovery postoperatively and decrease the length of hospital stay in ICU **[16]**. Regular exercise, such as aerobic and resistance training, reduces contractility, myocardial oxygen demand, and cardiac work, all of which contribute to the development of submaximal work tolerance. A simplified physical exercise program may be considered a safe and effective clinical nursing modality that effects improvement in sedentary life style related physical function and well-being **[16]**. Furthermore,

it improves hemodynamic responses such as SPO_2, Distance walked and Dyspnea on exertion **[17]**. However, it is also important to note that PSEP training increases myocardial perfusion by lowering endothelial dysfunction and creates cardiovascular adaptations since it works big muscle groups by increasing their perfusion and beneficial in reducing their fatigue **[28]**. Because of this, it dilates the coronary arteries, which increases skeletal muscular strength, endurance, and PSEP tolerance as measured by the 6-MWT and PSEP test **[18]**.

CONCLUSION:

In conclusion, the study demonstrates that PSEP significantly improves shortness of breath, SPO2, and overall well-being in post-operative CABG patients. The 6MWT is both feasible and well-tolerated, enhancing functional status and reducing complications. Future long-term studies could further explore the impact of physiological factors and psychological interventions on recovery.

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