Protocol

Cost effectiveness and functional outcomes of smartphone cardiac rehabilitation assisted self-management versus centre based cardiac rehabilitation among patients with coronary heart disease in Southern India: a multicentre randomized clinical trial protocol

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ABSTRACT

Background: To attain the world specific indicators of quality on programs which brings rehabilitation for cardiac diseases and surgeries in India are to be brought to meet the international standards. Dearth of published research on cost effectiveness of smart phone application oriented CR assisted self-management (SCRAM) over centre based (CBCR) in Indian Population drives this study to be done. This study aims to analyze cost effectiveness of SCRAM versus CBCR in coronary artery disease (CAD) patients.
Methods: In this multicentre randomized clinical trial, 100 subjects with uncomplicated CAD will be recruited through purposive sampling and divided into group A and B through block randomization. Group A will be treated with CBCR whereas group B with SCRAM. Outcome measures of 6 minutes' walk test distance, talk test values and SF 36 scores, high density lipoprotein level and 3 months' average blood glucose level were documented pre and post interventions and 3, 6, 12 months follow up for data analysis. This study will follow human study ethical consideration based on Declaration of Helsinki.
Conclusions: Cost effectiveness of experimental group where SCRAM given as intervention may be better post intervention than control group where CBCR given. By this way this RCT protocol may bring the execution cost down with coronary heart disease patients which play a major role in participation of these patients in CR programs.
Trial registration: The trial was registered with CTRI – Clinical Trial Registry of India (ICMR) - CTRI/2022/11/047143 (registered on: 09 November 2022) - trial registered prospectively.

Keywords: Cardiac rehabilitation, Cost effectiveness, Clinical trial protocol, Coronary artery disease

INTRODUCTION

The prime factor for death globally is cardiovascular disease (CVD).[1] Universally followed interventions for CVD include drugs to improve haemodynamics of heart, revascularization surgeries like percutaneous coronary angioplasty and coronary artery bypass grafting (CABG). But overall healthcare for cardiac diseases included cardiac rehabilitation (CR) through risk factor corrections and patient oriented individualized structured exercise protocol worldwide.[2]

Heart diseases with other non-transferring communicating illness are the prime reason of disease induced limitations in overall health and fatality globally.[3] CR acts as an important tool in minimizing the causative agents like habits of smoking, control of lipid disorganization and sedentary life style. They can play a major role on activities of standard daily living in those patients. CR can

contribute to minimize these factors and may improve functional outcomes of daily living post heart diseases.[4]

CVD are responsible for 17% of whole mortality and 26% of in fatality in adults in 2001-2003, The Registrar General of India reported claimed, and it reached to 23% of whole and 32% of fatality in adults around 2010-2013. The World Health Organization (WHO) and Global Burden of Disease Study have also marked the growing scenario in life time in lost years and disability-affected life time which happen because of cardiac diseases. In India, published research have stated increase in heart diseases for the past 60 years to around 10% in populations dwelling in cities and around 6% in villages. In India the age related cardio vascular diseases induced deaths are around 349 in 1 million males 265 in 100,000 females. These trends are 2 to 3 folds more than in the United States (US).[5]

Diseases affecting coronary arteries are leading heart diseases which are known to produce reduction in functional outcomes in day to day life.[6] Coronary artery bypass operations and angioplasties are well known in the treatment diseases affecting coronary arteries.[7] Cardiac surgeries lead to reduced physical and function oriented capabilities, because of complications of invasive and open heart surgeries, long hospital stay, medicine oriented adversities which later lead to sedentary life style with less physical exertion.[8] However, bypass cardiac procedures are known to influence functional and psychological well-being of an individual and that leads to better healthy life for 60 months period.[9]

Comprehensive multidisciplinary rehabilitation programs for cardiac diseases in India provide significant positive changes in different functional outcomes of cardiac diseases. However, patient evaluation disparities, assessment of factors causing heart diseases, data related to outcome parameters and diseases status, recordings of data are not meeting the required standard in India. World specific indicators of quality on programs which brings rehabilitation for cardiac diseases and surgeries in India are essentially to be brought to meet the international standards.[10]

WHO endorsed rehabilitation for cardiac diseases should be multidisciplinary organized and coordinated interventions structures to bring into optimum level of a heart disease patient's overall wellbeing including physical, psychological and social well-being by bringing down the progression of atherosclerotic process and even reversing it.[11] Cardiac rehabilitation has 3 structured phases: hospital based phase I which last for initial 1-2 weeks and followed by supervised functional regaining phase II for the next 3 to 6 months, and the tertiary community level phase III.[12]

Rehabilitation for cardiac diseases (CR) is a class 1 level A recommendation to treat the heart disease. In a latest research to draw the structure cardiac rehabilitation programs around the world, the standard of rehabilitation program for cardiac diseases in India is on the higher side which ranks 3 on a scale 1 to 14, where 1 is to be known best quality and is poorest quality.[13,14]

Center-based CR are getting affected by various influencing factors and barriers like affordability and program availability, restrictions to reach centre which are providing cardiac rehabilitation, family and social responsibilities, and dwelling areas. Setting a cardiac rehabilitation centre in different areas ranging from modern to tribal locations can maximize the accessibility, at the same time that might not be possible, given the economic cost needed to develop state of art facilities to execute center-based cardiac rehabilitation.[15]

Smart phone based digital tele-rehabilitation are given to remote areas via modern technologies can advance the access related obstacles which can minimize the attendance in economically costly centre-based CR. Significance of digital based modern tele-rehabilitation, which has mobile and telephones, networks and communication through audio visual electronic modern devices has been demonstrated in a study.[16]

Numerous research works are available for the importance of cardiac rehabilitation.

But there are very limited resources are available for tele-rehabilitation for coronary heart disease patients both medically and surgically managed.

There are very limited research resources available to understand the effectiveness of economic cost and physical, social and overall outcomes including physical, social, psychological and functional well-being of digital mobile phone associated rehabilitation for cardiac diseases self-management in the treatment of coronary artery disease (CAD) patients throughout the world in general and in India particular.

Aim of this study

The aim of the study was to analyse and compare the cost effectiveness and functional outcomes of smartphone assisted cardiac rehabilitation self-management (SCARM) versus centre based cardiac rehabilitation on coronary artery disease patients in Southern India.

Objectives of this study

Objectives of the study were: to analyze and understand the effect of generalized cardiac education on modifiable cardiac risk factors and cost execution among urban and rural dwelling individuals with cardiac diseases of compromised and revascularized in Southern India; to analyze and understand the effect of usual center based rehabilitation for cardiac diseases on modifiable risk factors related to cardiac diseases and economic based execution of cost among different areas ranging from

modern urban to village level patients with cardiac diseases of compromised and revascularized in Southern India; to analyze and understand the effect of digital smartphone associated rehabilitation for cardiac diseases assisted self-management on modifiable cardiac risk factors and economic based execution of cost among different areas ranging from modern urban to village level patients with cardiac diseases of compromised and revascularized in Southern India; and to compare the effect digital smartphone associated rehabilitation for cardiac diseases assisted self-management (SCRAM), center based rehabilitation for cardiac diseases (CBCR) and generalized cardiac education on modifiable cardiac risk factors and cost execution among different areas ranging from modern urban to village level patients with cardiac diseases of compromised and revascularized in Southern India.

METHODS

Study design

The study was a multicentre randomized clinical trial.

Study setting

The study was conducted in multi-centres in Madurai and Mangalore where the subjects have to be recruited in this study.

Study duration

The duration of the study was from November 2022 to October 2024.

Study sampling

The sampling of the study was purposive sampling.

Randomization

Block randomization was used in the study.

After the demographics, recruited cardiac patients will be randomly divided into two groups, group A and group B using block randomization. There will be four blocks, with the matrix design of 4×23; here 23 being rows. Each block contained 4 chits (2 chits for each group), totaling 92. But the last row (23rd row) will contain only two blocks, one for each group. By the block randomization method, recruited cardiac patients will be randomly allocated using sequentially numbered, opaque sealed, envelopes (SNOSE). Recruited cardiac patients will be allotted to the group based on the randomly chosen chit by them. The physiotherapist who is not involved in this research will perform the randomization. Once the first row of all the blocks will be allotted, the next row block will be opened for recruitment. Thus, an equal number of cardiac patients will be assigned to each group over time.

Sample size

Sample size and power

Sample size for the study was calculated using G*Power ver. 3.1.9.7 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany; http://www.gpower.hhu.de/) for the priori sample size calculations with expected effect size (ES), f=0.4 (large effect) under analysis of covariance (ANCOVA). By substituting ES with the level of significance as 0.05 (α error prob), 0.90 (power (1-β err prob) with two groups and one covariates, we have estimated the total sample size has to be, n=68. By considering a 30% drop-out rate (n=20.4), we have obtained the final minimal required sample to be, n=89 (after rounded off to the next whole number) in each group. For the purpose of allocation convenience, we have targeted the total minimum sample, n=90. The above sample size estimation was performed using the proposed ES calculation as recommended by Peacock et al.[14]

Hence, the minimum sample size required in each group to attain 90% power (type II error=10%) with 5% level of significance (type I error=5%) is, n=45/group.

Blinding

The study was double blinded (subjects and investigators).

Study population

The study population included non-compromised and revascularized cardiac patients in and around South Karnataka and South Tamil Nadu comprised 9 districts from Madurai to Kanyakumari and Mangaluru, South Karnataka District who seek medical and post revascularization treatment in Madurai and Mangaluru Hospitals.

Study sample

The study sample included 100 individuals with non-compromised and revascularized cardiac disease patient who need cardiac rehabilitation will be recruited for this study based on sample size calculation.

Criteria of selection

Inclusion criteria

Patients of age 50 to 70 years, both the sexes, uncomplicated non compromised CHD and revascularized cardiac patients diagnosed 6 months before, referred by cardiologist, outpatients who are non-compromised cardiac related clinical status for at least 6 weeks, capacity to perform 50–75% of sub maximal aerobic and cardiac conditioning exercises, and patients able to understand written and verbal commands in their respective languages – Kannada and Tamil minimum were included.

Exclusion criteria

NYHA functional class III/IV heart failure patients, complicated and compromised CHD, CHD with neurological impairments, CHD with orthopedic and other severe systemic impairments, significant non CHD exercise limitations like amputations, terminal diseases/illness and patients with contraindication maximal exercise testing were excluded.

Outcome measures

Primary outcome measures

Primary outcome measures included six-minute walk test distance (6MWTD), talk test, SF–36 questionnaire, and economic cost-incremental cost-effectiveness ratio (ICER).[17-19]

$$ICER = Ci - CUC/Bi - BUC'$$

Where C=costs, B=benefits, i=SCRAM intervention and UC=usual care CR.

Secondary outcome measures

Secondary outcome measures included high density lipoprotein levels from lipid profile test, and random blood sugar levels – 3 months average.

Interventions

Interventions included usual care cardiac rehabilitation program in a rehabilitation unit of a hospital or a rehabilitation centre for control group (group A), and SCRAM in experimental group (group B).

Procedure

100 individuals with non-compromised and revascularized cardiac diseases whose fulfills the criteria of selection will be recruited in this proposed study through purposive sampling.

Baseline values of primary and secondary outcome measures along with demographic data will be recorded by sub tester who will be holding BPT degree with minimum 3 years clinical experience post-graduation of BPT. Subjects will be divided into control and experimental group of 50 each thorough block randomization method. Control group (group A) will receive centre based cardiac rehabilitation from 2nd week immediately after hospital stay whereas the experimental group (Group B) will receive SCRAM up to 24 weeks.

Written informed consent form

Written informed consent of subjects will be taken before recruitment for the study.

Control group (group A)

Centre based cardiac rehabilitation from 2nd week (phase II cardiac rehabilitation) up to 24 weeks (phase III cardiac rehabilitation).

Based on FITT principle (Karvonen method), the subjects target heart rate will be calculated and aerobic exercise program basically treadmill walking with submaximal effort (50–75% heart rate reserve) will be given in cardiac rehabilitation unit in a hospital or centre.

Experimental group (group B)

SCARM from 2nd week (phase II cardiac rehabilitation) up to 24 weeks (phase III cardiac rehabilitation).

Based on FITT principle (Karvonen method), the subjects target heart rate will be calculated and aerobic exercise program basically brisk walking with submaximal effort (50–75% heart rate reserve) will be given as SCRAM in home.

FITT principle

Frequency was 1 session/day, 5 sessions/week; intensity was 50% target heart rate for the first 4 weeks, 55% target heart rate for second 4 weeks, 60% target heart rate for third 4 weeks, 65% target heart rate for fourth 4 weeks, 70% target heart rate for fifth 4 weeks, and 75% target heart rate for final sixth 4 weeks.

Time

Time was 60 minutes a session, 10 minutes of warm up with flexibility and stretching exercises for whole body, 40 minutes of aerobic exercises, and 10 minutes of cool down with flexibility and stretching exercises for whole body.

Type

Type of exercise was aerobic exercise program, treadmill walking for centre based cardiac rehabilitation for group A – control group), and brisk walking for SCRAM for group B – experimental group.

Both groups will receive the intervention of 60 minutes a session per day, 5 days per week for 24 weeks. Their post intervention values of outcome measures will be taken and recorded for future statistical analysis by the sub tester.

Home education program of aerobic exercises of brisk walking with warm up and cool down will be taught and monitored to follow for the following 1 year after successful completion of intervention in both groups.

Follow up

At 3, 6 and 12 months follow up will be done.

Outcome measures of 6MWT variables, talk test, economic cost and high density lipoprotein, random blood sugar will be recorded by a sub tester investigator recruited in this study with BPT degree with minimum 3 years clinical experience post-graduation of BPT.

Data analysis

Shapiro-Wilk test will be used to check the recruited cardiac patients to what extent the data match the normal distribution.[20]

Student paired 't' test will be used for descriptive statistics of the normally distributed data and it will be expressed in mean±standard deviation format. Pre and post intervention values of outcome measures in group A and B will be analyzed with student paired t test. Repeated measures analysis of variance (ANOVA) will be used for comparison of the intervention changes in the outcome measures at 3rd and 6th month from the baseline, while between group analysis will be done with independent 't' test. If the data is not normally distributed, mean with 95% confidence interval and range will be taken for descriptive statistics. Non-parametric tests of Wilcoxon signed-rank test and Mann-Whitney U test will be used to find out the differences within and between group analysis at 3rd and 6th month from the baseline before intervention.

Two-way ANOVA will be used to analyze the interaction between two independent variables, gender and treatment effect on the dependent variable, outcome variable 2×2-factor design.[21] Friedman's two-way ANOVA will be used for not normally distributed data. To adjust the post-intervention outcome scores to their pre-intervention/ baseline scores as covariates, ANCOVA (if data follow normal distribution) or non-parametric Quade's test for ANCOVA will be used.[22]

This would help us in equating group-A and group-B with reference to their pre-intervention/baseline scores. Data analysis will be done by using statistical package for the social sciences (SPSS), IBM SPSS version 25.0.[23] For all the analyses, a $p<0.05$ will be kept as significant. Thus, type I error was set less than 5%. This was really an arbitrary value recommended by standard research methodology book to minimize type I error in advance.[24]

DISCUSSION

The concept of cardiac rehabilitation in their home as 3rd phase of CR has been in practice since long ages to get functional quality of life in cardiac patients of non-compromised and revascularized cardiac patients. But the participation of cardiac patients in HBCR has been jeopardized because of lack of attention of patients to carry out cardiac rehabilitation and its execution cost.

COVID-19 over the world has created the need of HBCR cardiac rehabilitation than ever before. In developed countries like Australia has given importance to digital based cardiac rehabilitation like through smart phone assisted cardiac rehabilitation and different way of executing cardiac rehabilitation with modern technological help to reduce economic cost of CR in prevention as well as gaining maximal functional output cardiovascular disease patients.[19]

Understanding of importance rehabilitation for cardiac diseases in India and its benefits of post heart diseases is better, but at the same time the execution of rehabilitation for heart diseases in India, because of its execution economic cost is very well limited.[11] Participation in phase 2 and 3 of CR after hospitalization phase 1 of CR is affected by so many factors including economic cost as prime factor. So, modification in the execution of CR by using modern advance digital way of approach is effective and much needed one to increase the participation of post cardiovascular disease patients. India like developing countries, the significance of finding new available feasible way of executing CR draws more attention.

This area should get significant importance in order to increase the effect of digital based CR and its easier recruitment of patients to perform cardiac rehabilitation like SCRAM. There are very limited resources and literature are available worldwide. In developed countries also since 2020 only much importance has been given to telemedicine and tele-rehabilitation concepts because of COVID-19 pandemic and economic constraints. In India, there is huge need and gap in this research aspect that has to be explored very soon to excel par with developed countries. This study will add the needed inputs in future to grow further.

CONCLUSION

Functional outcomes with economic cost effectiveness of SCRAM shall be significantly better than centre based cardiac care rehabilitation to the subjects with coronary artery diseases.

Recommendations

This area is to be given importance in order to maximize the effect of cardiac rehabilitation and its easier recruitment of patients to perform cardiac rehabilitation like SCRAM.

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