


CARDIAC REHABILITATION AND EXERCISE TRAINING -
CHALLENGES AND FUTURE DIRECTIONS
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ABSTRACT
Cardiac Rehabilitation (CR) is an interdisciplinary program of education and exercise established to assist individuals with heart disease in achieving optimal physical, psychological and functional status within the limits of their disease.

As CVD is a multifactorial disease, the beneficial outcomes from CR are numerous. Possible outcomes include improvement in lifestyle, reduction in CVD risk factors, cost of care, disease progression, morbidity, and mortality. The prevention of subsequent coronary events and the maintenance of physical functioning in such patients are major challenges in preventive care.

Comprehensive rehabilitation offers physical training, nutritional advice, and psychological therapy as well as health education, social support and including assistance for return to work. But individual patient needs for constituent elements of the total programme vary widely.

INTRODUCTION:
Rehabilitation is understood by most of us as that process enabling, encouraging and assisting patients to make the transition from a state of illness back to a state of health, as near as possible to normal.

Cardiac Rehabilitation CR is an interdisciplinary program of education and exercise established to assist individuals with heart disease in achieving optimal physical, psychological and functional status within the limits of their disease.

Cardiac rehabilitation programmes have developed in a number of Countries over the past twenty years. Initially most programmes concentrated on patients having acute Myocardial infarction. Programmes have been developed more recently for patients discharged after elective procedures (coronary artery bypass graft and percutaneous transluminal coronary angioplasty) and for patients with chronic stable angina. While the over-all objectives of rehabilitation, focus to facilitate the patient’s return to as near normal possible; even though the protocols followed are common

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Regular dynamic exercise as a rehabilitative measure is accepted as the major component of a cardiac rehabilitation programme.

Research and Clinical activities have reached the point where evidence, clinical practice and professional experience have recommended exercise training in CR.

Non-compliance in continuation of the programme should be focused and measures to make patients to continue as home based programme in INDO should be implemented.

New models of CR need to be developed in our country. These new CR programs will need to address issues of promoting long-term adherence, improving accessibility, particularly for patients in rural community and addressing the growing need for CR in elderly.

An individualized program should be developed in close collaboration with the patient's primary care and needs.

Key words: Cardiac Rehabilitation CR, Coronary Artery By pass CABG, Myocardial infarction MI, Cardio Vascular Diseases CVD

Rehabilitation therapists will appreciate the relevance of both treatment and prevention to rehabilitation in so far as they impinge as rehabilitation practice, and both are included.

Most rehabilitation programmes, whether predominantly exercise based, or predominantly psychological based, are comprehensive; include some patient education on the heart, heart disease, risk factors including life style modification during treatment and management in hospital. Rehabilitation therapists should have sound knowledge in managing these patients.

As the concept of comprehensive rehabilitation gained acceptance, revascularization of the myocardium by coronary artery bypass graft surgery or by angioplasty became increasingly common. It is apparent that a poor functional outcome of surgery was the result of the same mixture of physical, psychological, social and economic factors [1]. So, during the '80s the indications for cardiac rehabilitation widened to include these patients. Those with stable angina, following surgery for valvular heart disease [3] or after cardiac transplantation [4] were also shown to improve after rehabilitation. More recently, as evidence has accumulated cardiac rehabilitation benefits older people [5], those with poor left ventricular...
function[6] or with a low ischemic threshold[7]. Rehabilitation should also be considered in patients known to have coronary heart disease but who are free of symptoms and in those at high risk of developing the disease. Educational counseling and behavior modification are also important aspects.

Risk factors and primary prevention include stopping smoking [8], having a controlled lipid levels [9, 10], increasing physical activity [11, 12], controlling hypertension [13], reducing alcohol [14], altering diet and reducing mental stress. Also hormonal replacement therapy reduces the risk of coronary disease in the post-menopausal woman. [15]. An overall life style modification is necessary. By becoming more physically active and doing small bouts of exercises, must be the first step towards life style modification.

The Role of Exercises Training In Cardiac Rehabilitation

The concept of exercise training as a therapy for patients suffering from coronary heart disease was emphasized by a English Physician, William Heberden, who was the first to describe the classical picture of effort-induced angina pectoris, also recorded the case of a patient "Who set himself the task of sawing wood every day and was nearly cured". Irish physician William Stokes published his classic work, "The Diseases Of The Heart And Aorta" in which he wrote, "the symptoms of debility of the heart are often removable by a regulated course of gymnastics, or by pedestrian exercises."

After Stokes' death in 1876, Prolonged immobilization in bed became the mainstay of medical care for close to a century and seldom was it practiced more assiduously than after an acute myocardial infarction. The physician insisted that the heart attack survivor be nursed in bed for eight weeks or more, washed and fed, and not even allowed up to use the bedside commode. The time of hospital discharge may be often three to four months after acute event and the patient becomes severely deconditioned, weakened, demoralized, and permanently unemployable others.

The annual meeting of the American Medical Association, held in Chicago in 1944 included a symposium on "The abuse of rest in the treatment of disease" at which for the first time physicians collectively questioned the wisdom of prolonged immobilization.

In 1952, Levine and Lown introduced their innovative "armchair treatment", in which they progressed their patients to sitting up in chair by the side of the bed a few days after admission[16].

Throughout the '50s and '60s there were number of reports on the beneficial effects of early ambulation and progressive graded activity[17, 18].

From early mobilization to a formal inpatient exercise regimen was a natural progression. Pioneers in this area were Wenger and Zohman[19] who encouraged low level self care activities to be commenced early in the coronary care unit, which was followed even after transfer to the general ward, by more strenuous activities of daily living and monitored upper and lower limb strengthening exercises.

Gothenber of Israel was the first to embark upon a large scale post coronary out patient exercise training programme. Under his guidance some 1100 patients completed five years of endurance training, which included activities such as walking, jogging and cycling.[21] Over a five year period the average annual fatal recurrence rate was 0.88% compared with 4.8% per year for non-exercised patients. These results attest to the safety of supervised physical training for patients recovering from an uncomplicated myocardial infarction.

In North America, Hellerstein of Cleveland was one of the early supporters of in post - coronary rehabilitation. In 1968 he described the results of a three year exercise programme involving 254 patients. In Canada, Rechinitzer and his associates from London & Ontario, first reported in 1967 on the short term benefits of a six month training programme and in 1972 published a five year follow up that compared data with results from patients treated at other hospitals in the London area[22].

A report on seven post coronary patients from the Toronto programme in the 1973, Boston Marathon [23] demonstrated that high level of fitness can be achieved by supervised training. Immediate studies in few years also focused on considerable attention on cardiac rehabilitation and did much to convince patients and public alike that most heart attack survivors could lead a full and active life[24, 25].

By the '80s, the demonstrable benefits of exercise rehabilitation training were sufficiently convincing that the various national and international heart associations were urging acceptance. In 1981 the council on Scientific Affairs of the American Heart Association recommended that "Cardiac rehabilitation should be considered one of the treatments for coronary heart disease complementary to drug therapy or surgery[26]. The following year the World Health Organization concurred, recommending "regular dynamic exercise as a rehabilitative measure is accepted as the major component of a cardiac rehabilitation programme[27]. The beneficial effects of aerobic training include improved efficiency of oxygen transport system, allowing an increase in maximal work capacity as well as greater tolerance for prolonged sub maximal physical tasks. Exercises brings about Structural and functional changes in working muscles, with enhanced ability to store and utilize carbohydrate and fat, as well as extract more oxygen from circulating blood[27].

The rate pressure product is decreased at the same sub maximal levels of effort, thereby reducing the workload on the heart muscle by doing regular exercises. For the angina sufferer, this means that a higher level of effort is possible
before the onset of symptoms. The stroke volume is increased as a result of augmentation in end diastolic volume, and enhanced myocardial contractility. In the presence of coronary artery disease, possible stabilization of atherosclerotic plaque, and/or improvement in blood supply to heart muscle by collateralization and/or regression in plaque size, may be possible.

The following changes also occurs due to exercise. They are, restoration of self confidence, improvement in mood, and alleviation of depression, reduction in CAD risk factors, decreased body fat, lowered serum triglycerides, increased HDL cholesterol and decreased total cholesterol/ HDL-Cholesterol ratio, increased insulin sensitivity and glucose tolerance (important in Type II diabetes), enhanced fibrinolytic activity, decreased resting and exercise plasma catecholamine levels (with increased resistance to stress and increase in threshold for ventricular fibrillation)[27].

The Current Trend

During 1980 to 2005, there were more studies showing beneficial outcomes from CR. Possible outcomes include improvement in lifestyle, reduction of CVD risk factors, cost of care, reduction in disease progression, morbidity, and mortality. CVD is also a major cause of physical disability, particularly in the rapidly growing population of elderly persons [28, 29].

The prevention of subsequent coronary events and the maintenance of physical functioning in such patients are major challenges in preventive care. Cardiac rehabilitation programs were first developed in the 1960s, [30,31] once the benefits of ambulation during prolonged hospitalization for coronary events had been recognized. [32] After discharge from the hospital, the process of physical reconditioning was continued at home. The focus of these programs was almost exclusively on exercise. The hospital stay for acute coronary syndromes has now been shortened to three to five days so that deconditioning is minimal. [34]

With shorter stays, however, the opportunity to train patients about risk reduction and exercise is less. There is convincing evidence that regular exercise and modification of risk factors favorably alter the clinical course of coronary heart disease. [35,36]

The benefits of cardiac rehabilitation and secondary prevention are broad and compelling. Controlled trials of exercise after myocardial infarction, reported in the 1980s, have demonstrated reductions in overall mortality and in mortality from cardiovascular causes. [35,36]

Trials of exercise combined with nutritional counseling have demonstrated a slowing of the atherosclerotic process [37,38] and decreased rates of subsequent coronary events and hospitalization.

Home-based rehabilitation programs that are directed by physicians and coordinated by nurses have been developed as a way of expanding the delivery of secondary prevention services [35,36].

Over the past 30 years, exercise therapy has evolved as one of the important components of CR. These programs also include nutrition counseling, smoking cessation, weight management, psychosocial counseling and metabolic risk factor management, can be found in many hospitals and communities. The target population for CR has expanded, and includes men and women of all ages and those presenting with nonischemic CVD. Several national organizations have published extensive recommendations and guidelines for CR [39].

Challenges of CR

Even though there are numerous benefits of CR, several challenges exist that are common to most programs. These challenges include low participation rates, gender-based referral and participation; problems with adherence, dropouts and resource management. Participation rates in CR programs by those eligible patients are less. Possible reasons may be lack of referral, distance to CR facility, lack of motivation, and patient's unwillingness to attend [40,41].

It is noted that referral rates are lower for women than men; however, it has also been reported that women are more likely to drop out of a CR program once referred [40].

The benefits of CVD risk reduction are only realized through long-term lifestyle and risk-factor management. CR dropouts and adherence continue to pose a challenge to the success of CR. Even after CR participation, adherence rates to favorable lifestyle behaviors have been reported to decline. However, good comprehensive data on adherence following completion of CR and its influence on risk-factor modification are not available [40,41].

Future directions of CR

As CR has evolved in the past 30 years, it has proven its value in the treatment of patients following MI and post CABG. In the coming years, the challenges will be no less demanding. As new target patient populations are recruited into CR programs and new models as well should be developed. Strategies for improving participation rates need to be developed, focusing on education of patients and health care providers. Extra efforts should be directed towards reducing the gender inequity. The possibility of disease regression needs to be explored in larger populations using clinically relevant practices [41].

The new CR programs will need to address issues of promoting long-term adherence, improving accessibility, particularly for patients in suburban and rural communities, and addressing the growing need for CR in an aging population. Future CR programs will also need to be resource sparing, as current health care organizations cannot meet the demand of all eligible patients. For those patients living in rural areas, new communication technologies may be useful in delivering CR through telemedicine initiatives.
Integration of patients’ family physicians and other health care providers is a potential strategy to improve adherence, as are behaviour strategies aimed at patient empowerment. Other forms of contact than the traditional face-to-face session can be incorporated into CR as a method of continued follow-up and reaching those patients in nonurban areas. The growth of telemedicine can play a vital role from the simple use of the telephone, to the Internet and the use of personal digital assistants. Integration of these and other tools can address a number of the issues of CR [41].

CONCLUSION

Research and clinical activities have reached the point where evidence, clinical practice, and professional experience have recommended exercise training in CR.

Cardiac rehabilitation has exclusively not been used and studied in patients at relatively low socioeconomic levels. However, the prevalence of coronary heart disease among persons at lower socioeconomic levels is increasing. Noncompliance in continuation of the programme should be focused and measures to make patients to continue as home based programme in India.

An individualized program should be developed in close collaboration with the patient’s primary care and needs [40].

To end, complete medical and physical fitness evaluation for middle age group targeting preventive rehabilitation should be on focus. Change in life style will prevent or slow down the development of heart disease. Regular medical check up, proper diet, supervised regular exercise, weight reduction, control of diabetes, control of high cholesterol and high blood pressure, stopping smoking and reduction in the stress may keep the heart more fit for the rest of the life.

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SIX MINUTE WALK TEST: A LITERATURE REVIEW

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ABSTRACT:

Exercise testing forms an important part in assessment of any patient requiring physical training. The methods of such exercise testing have undergone enormous changes. Apart from being a basis for training, such testing procedures have helped to delineate patients having high risk from beneficiaries for major surgical procedures. The conventional methods of physical capacity evaluation needed many sophistications and facilities to make them reliable and safe. In developing countries like India, the cost of treatment burdens the patient, as most is spent on initial assessment. Moreover periodic evaluation is precluded due to lack of the required setting all times. Thus, the usage of field tests gained importance, as they are noninvasive, easy to administer, patient friendly and cost effective. Initially twelve-minute walk test (TMWT) was developed to assess the exercise capacity of patients with respiratory dysfunction, as they were unable to complete the conventional sub maximal exercise testing. The TMWT also posed limitation to patients with moderate to severe cardio respiratory dysfunction. Hence Six-minute Walk Test (SMWT) was developed and validated in different patient groups. The importance of SMWT was recognized and usage widened from being a basic exercise testing of patient to the level of prediction of patient outcomes, reflection of quality of life, prediction of mortality and morbidity. This review intends to describe and analyse the clinical utility of the most widely used field test. It also outlines the limitations and future applications to be explored.

Key words: Six minute walk test, exercise testing, Cardiopulmonary rehabilitation

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INTRODUCTION:

Exercise testing is an important component of initial patient assessment in cardiac rehabilitation. Assessment of functional exercise capacity has gained importance in the patient care in various diseased states. Timed walking tests are widely used to evaluate functional exercise performance, as they are likely to measure the ability to undertake the activities of day-to-day life. Functional capacity is an important clinical outcome measure in rehabilitation of any patient and thus necessitating an exercise testing procedure.11

Assessment of functional capacity was traditionally done by asking patients about the work capacity like how many times they climb stairs, or how much they walk etc. However these recollection methods and questionnaire methods most often report over estimation or under estimation of the true functional capacity.

Exercise Testing:

An objective exercise testing procedure was developed by using a treadmill or bicycle ergo meter to determine maximal exercise capacity. Maximal exercise testing has been extensively validated for diagnosis, prognosis and exercise prescription. Maximal exercise testing requires specialized facilities, equipment and personnel and is associated with considerable cost. However, most of the human activities are always associated with sub maximal exercise capacity level. Hence sub maximal exercise testing were considered to be safe and feasible for more debilitated patients or patients with low exercise capacity or high risk population for graded, maximal exercise testing.

Field tests:

In 1960's Balke developed a simple walk test with defined period of time which was later modified to twelve minute walk test.16 When this 12 minute walk test was performed in patients with respiratory and cardiac problems, it was too exhausting and therefore a six minute walk test was developed which is easy to administer, better tolerated and more reflective of daily activities of living.24 The six minute walk test was developed by Guyatt et al. for exercise testing before exercise prescription.28

Lipkin has first introduced the 6MWT as a functional exercise test in 1986. Its results were highly correlated with those of the 12-minute walk test from which it was derived and with those of cycle ergometer or treadmill based exercise tests. The 6MWT was also found to be a valuable instrument to assess progression of functional exercise capacity in different clinical intervention studies.

In a cardiac rehabilitation set up while prescribing exercises, six minute walk test as originally described by Lipkin et al.20 can be used for both initial assessment and document functional outcomes after completion of cardiac rehabilitation program.37 There are equations in six-minute walk test using which, the distance walked can be converted into a measure of functional capacity (vo2max).38 The distance walked can be used as the marker of disease, severity, and prognosis and as the outcome measure in clinical trial testing in medical and surgical procedural therapy.
Validity and Reliability of 6MWT:

Usually age, gender, height, body mass determine the walk performance in adult population.(20, 21) According to American association of cardiovascular and pulmonary rehabilitation (AACVPR) risk stratification most of the adults having history of sedentary life style and low physical function, determined by SF 36 questionnaire(22), showed corresponding low performance in 6MWT. There are several studies that have assessed the correlation between the functional capacity derived out of 6MWT and symptom limited graded exercise testing and found to be highly correlated.(23)

There is maximum correlation in the rehabilitation equivalent value when compared to rate of perceived exertion suggesting that the 6MWT is more a sub maximal exercise test(24, 25) and hence can be considered as the exercise testing procedure in cardiac rehabilitation set up.(26) The reliability of the test in healthy elderly persons and patients were high (Intra Class Correlation = 0.93) and it has been established as a valid and reliable test to assess the exercise capacity of various patient groups.(27)

The baseline 6MWT distance in (UAB) University of Alabama at Birmingham cardiac rehabilitation program of ischemic heart disease patients in total number of n = 30 was mean equivalent to 1351 feet ± 361.411 meter with minimum value of 120 feet (36 meters) and maximum value of 2322 feet (707 meters). A British cardiac rehabilitation program reported an improvement in 6-min walk distance from 1032 ± 249 to 1238 ± 258 ft over 6 weeks of training (two exercise sessions per week) but did not indicate the proportion of patients improvement.(28)

Technical Aspects of the 6MWT:

A complete description of the test is given by ATS.(29)

Location

The 6MWT should be performed indoors, along a long, flat, straight, enclosed corridor with a hard surface that is seldom traveled. If the weather is comfortable, the test may be performed outdoors. The walking course must be 30 m in length. A 100-6 hallway is, therefore, required. The length of the corridor should be marked every 3 m. The turnaround points should be marked with a cone (such as an orange traffic cone). A starting line, which marks the beginning and end of each 60-m lap, should be marked on the floor using brightly colored tape.

Required Equipment

1. Countdown timer (or stopwatch)
2. Mechanical lap counter
3. Two small cones to mark the turnaround points
4. A chair that can be easily moved along the walking course
5. Worksheets on a clipboard
6. A source of oxygen

7. Sphygmomanometer
8. Telephone
9. Automated external defibrillator

Patient Preparation

1. Comfortable clothing should be worn.
2. Appropriate shoes for walking should be worn.
3. Patients should use their usual walking aids during the test (cane, walker, etc.).
4. The patient’s usual medical regimen should be continued.
5. A light meal is acceptable before early morning or early afternoon tests.
6. Patients should not have exercised vigorously within 2 hours of beginning the test.

Measurements

1. Repeat testing should be performed about the same time of day to minimize intra-day variability.
2. A “warm-up” period before the test should not be performed.
3. The patient should sit at rest in a chair, located near the starting position, for at least 10 minutes before the test starts. During this time, check for contraindications, measure Pulse and blood pressure, and make sure that clothing and shoes are appropriate.
4. Pulse oximetry is optional. If it is performed, measure and record baseline heart rate and oxygen saturation (SpO2) and follow manufacturer’s instructions to maximize the signal and to minimize motion artifact. Make sure the readings are stable before recording. Note pulse regularity and whether the oximeter signal quality is acceptable.
5. Have the patient stand and rate their baseline dyspnea and overall fatigue using the Borg scale.
6. Set the lap counter to zero and the timer to 6 minutes. Assemble all necessary equipment (lap counter, timer, clipboard, Borg Scale, worksheet) and move to the starting point.
7. Instruct the patient as follows:
   “The object of this test is to walk as far as possible for 6 minutes. You will walk back and forth in this hallway. Six minutes is a long time to walk, so you will be exerting yourself. You will probably get out of breath or become exhausted. You are permitted to slow down, to stop, and to rest as necessary. You may lean against the wall while resting, but resume walking as soon as you are able. You will be walking back and forth around the cones. You should pivot briskly around the cones and continue back the other way without hesitation. Now I’m going to show you. Please watch the way I turn...”
without hesitation." Demonstrate by walking one lap yourself. Walk and pivot around a cone briskly. "Are you ready to do that? I am going to use this counter to keep track of the number of laps you complete. I will click it each time you turn around at this starting line. Remember that the object is to walk as far as possible for 6 minutes, but don't run or jog. Start now or whenever you are ready."

8. Position the patient at the starting line. You should also stand near the starting line during the test. Do not walk with the patient. As soon as the patient starts to walk, start the timer.

9. Do not talk to anyone during the walk. Use an even tone of voice when using the standard phrases of encouragement. Watch the patient. Do not get distracted and lose count of the laps. Each time the participant returns to the starting line, click the lap counter once (or mark the lap on the worksheet). Let the participant see you do it. Exaggerate the click using body language, like using a stop watch at a race. After the first minute, tell the patient the following (in even tones): "You are doing well. You have 5 minutes to go." When the timer shows 4 minutes remaining, tell the patient the following: "Keep up the good work. You have 4 minutes to go." When the timer shows 3 minutes remaining, tell the patient the following: "You are doing well. You have 2 minutes to go." When the timer shows 1 minute remaining, tell the patient the following: "Keep up the good work. You have 1 minute to go." Do not use other words of encouragement (or body language) to speed up. If the patient stops walking during the test and needs a rest, say this: "You can lean against the wall if you would like; then continue walking whenever you feel able." Do not stop the timer. If the patient stops before the 6 minutes are up and refuses to continue (or you decide that they should not continue), wheel the chair over for the patient to sit on, discontinue the walk, and note on the worksheet the distance, the time stopped, and the reason for stopping prematurely. When the timer is 15 seconds from completion, say this: "In a moment I'm going to tell you to stop. When I do, just stop right where you are and I will come to you." When the timer rings (or buzzes), say this: "Stop!" Walk over to the patient. Consider taking the chair if they look exhausted. Mark the spot where they stopped by placing a bean bag or a piece of tape on the floor.

10. Posttest: Record the postwalk Borg dyspnea and fatigue levels and ask this: "What, if anything, kept you from walking farther?"

11. If using a pulse oximeter, measure SpO2 and pulse rate from the oximeter and then remove the sensor.

12. Record the number of laps from the counter (or tick marks on the worksheet).

13. Record the additional distance covered (number of meters in the final partial lap) using the markers on the wall as distance guides. Calculate the total distance walked, rounding to the nearest meter, and record it on the worksheet.

14. Congratulate the patient on good effort and offer a drink of water.

Clinical Application:

Initially, SMWT was used as a field test to monitor the outcomes of therapy specifically in pulmonary conditions. Later was used to assess the exercise tolerance in patients with low work capacity and high risk group for graded, maximal exercise testing. Thus, gradually SMWT was used in cardiac rehab programs with validation with standard testing protocols and self-reported measures. The 6MWT data guides the exercise prescription in cardiac rehabilitation by making use of American College of Sports Medicine (ACSM) working equation.

Example of Using 6-Min Walk Data for Exercise Prescription:

Distance walked by the patient: 420 metres in 6 min. Calculate walking speed: Calculate speed in m/min: 420 m/6 min = 70 m/min Calculate metabolic value for walking without grade: 1 MET = 3.5 ml/kg/min; 0.1 is the constant for converting m/min to ml/kg/min. Estimated oxygen consumption (VO2): 3.5 ml/kg/min x 2.1 = 7.3 ml/kg/min. Thus, VO2 = 3.5 ml/kg/min + 7.0 ml/kg/min = 10.5 ml/kg/min. MET level achieved: 10.5 ml/kg/min / 3.5 = 3 METs. Metabolic value can be used for exercise prescription on apparatus other than treadmill MET, metabolic equivalent.

Using the caloric formula (VO2 MAX = 0.005 X 6MW DFT): also can be used Walker villalobos et al., have concluded in their study that 6MW T is more reliable in cardiac rehabilitation and have better correlation in term of VO2 Max. In their study they also concluded patients with a 6MW of less than 360 have low level exercise capacity and those with 6MW greater than 360 have moderate to high level of exercise capacity. They also use an equation to find the predicted value for 6MW equation 218 + (S.14 X HT IN CM - 5.32 X AGE) = (1.80 X WT + 51.31). It is observed that in healthy individuals will have a predicted 6MW of 631 ± 93 meter.

Widening Horizons:

Six-minute walk test is a universally accepted field test. It is safe, simple and well tolerated by most patients, even by frail elderly. It is reliable and feasible for many patient populations including the renal patients. The six-minute walk test (SMWT) is a simple, safe, and inexpensive test that uses an exercise mode relevant to everyday activities. The SMWT is a good measure of functional exercise ability because it is self-paced and sub maximal.
in nature. The SMWT is also well accepted by patients, easily administered, and can be reproduced. Recent studies indicate that six minute walk distance predicts the mortality in different groups of patients. The SMWT distance was found to be correlated with mortality prediction in patients with colon cancer and lung transplant. It is quite interesting to note that a recent study have found the prediction ability of the SMWT in patients with lung transplant, which was equivalent to predictability as that

of MELD (Model for End stage Liver Disease) score which is used for prioritizing patient waiting for liver transplantation. Thus, the applications of SMWT extends beyond Cardiopulmonary testing and monitoring therapy response.

Limitations:
The SMWT could be an useful method for fragile, debilitated individual but may not be a suitable tool for normal subjects and sports training as it does not show a correlation with maximal exercise testing in this population. Moreover, it have value of correlation rather than exact measure of sub-maximal exercise capacity of an individual. However, psychological factors such as depression and cognitive impairment all have a negative effect on the timed walking distance. The SMWT interpretation should include consideration of vascular, pulmonary, and musculoskeletal exercise limitations, as the mechanisms to limitation in the physical capacity might not have same physiological process and may have confounding variables also. The reliability in prediction of changes in VO2max among the patients awaiting cardiac transplantation still remains established.

Future directions:
The SMWT is well established for safe clinical test for variety of patients. As its role expands to prediction of outcomes of patients requiring surgical interventions and high risk individuals, the test needs to carefully used with due precautions taking into consideration of the limitations. The normative data, effects of medications, nutritional status, and level of racial differences in patient groups needs further testing before generalization. The predictive value still needs clarification due to less number of published data in various conditions other than cardiac and pulmonary diseases and need to consider the confounding variables as SMWT could not point out the source of deficit in all patients.

Conclusion:
Six minute walk test is a simple, valid and reliable field test with high level of patient compatibility and clinically sensitive with predictive of outcomes in different groups of cardiac and pulmonary patients. The normative and comparative data in Indian population for various groups is yet to be established, which could provide more insight on the minimal standards of exercise tolerance and predictive values in those patients. Thus, SMWT could serve as a clinically useful tool facilitating efficient method of estimating an individual's physical capacity with a functional test. The SMWT should be considered as useful complementary information about the functional status of patients with cardiovascular or pulmonary disease, while the utility needs further testing in other groups of patients.

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SUPERVISED EXERCISE TRAINING IMPROVES FUNCTIONAL CAPACITY DURING PHASE II CARDIAC REHABILITATION IN POST CABS PATIENTS

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ABSTRACT:
Background: Cardiac rehabilitation includes the essential component of graded exercise training with growing demand on individualized training methods to enhance the benefits of such training programs. Amidst the limitations in supervised training adherence, recent trends of evidence-based practice and younger age of surgical candidacy entrust to explore the benefits of simple and systematic exercise training in Indian settings.

Objective: To evaluate the benefits of simple and individualized training on functional improvement among post CABG patients.

Methodology: All the patients undergoing CABG at the super specialty center were screened for inclusion in this study. The eligible candidates were randomized into experimental (EXP) and Control (CON) group. The Phase I training remained same for the patients of both groups. Before discharge, the patients in control group were given routine care with counseling to continue self-monitored exercise. The subjects in Experimental group attended individualized training sessions under supervision. The functional capacity was assessed for patients in both groups at the time of discharge and after 12 weeks follow up.

Results: The pre-post walking distance of EXP and CON group were 140-433 and 143-268 respectively. The patients of EXP group were found to have significant improvement in their functional capacity following supervised exercise training than Control group (P<0.05).

Conclusions: The adherence to exercise program was a major limiting factor in this study. The patients who attended the supervised exercise program (EXP), had a significant improvement in their functional capacity in comparison to self-monitored training (CON) group.

Key Words: Cardiac Rehabilitation, coronary artery bypass grafting, phase II, supervised training.

Mesh Words: Exercise capacity, exercise training, six minute walk distance, physiotherapy

SRJM 2013;6;17-21

INTRODUCTION:
Over recent decades, coronary artery bypass grafting (CABG) has become one of the common treatment method for patients with Coronary Artery Disease (CAD) and after CABG, cardiac rehabilitation programs are considered important essential component.11 A Cardiac Rehab program consisting of exercise training, life style changes and psychosocial interventions are emphasized by several prominent health agencies.21 The benefits of mortality, morbidity, functional independence and Quality of Life have been explored and found have a reasonable health benefits with such systematic training.1-4.

The CR programs were also found to have cost effectiveness.22 Even low intensity exercises were safe to be done unsupervised for low risk patients,23 the extent of benefits of a tailor-made, supervised progressive training is sparsely available in Indian settings. The compliance of patient to supervised training has remained a challenge due to multiple factors. Tailoring the program to the patient's needs empowers the patient and improve adherence.25 India has a large population of coronary artery disease (CAD),26 but this concept has not gained momentum in India. Hence, this study on the effectiveness of Supervised Exercise Training during Phase II Cardiac Rehabilitation following CABG was taken up.

MATERIALS AND METHODS:
This was an exercise based interventional study. The study was approved by the Institutional Ethical Committee (IEC) of Sri Ramachandra University, Chennai. Since the expected prognosis is anticipated in 50% of subjects who participate in the study and the deviation may be 20% and with spontaneous improvement of control group being 25%, at the predicted significance at 5%, the total participants

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Fig. 1: Scheme of Study
was calculated to be 58 (Power analysis). Considering the
treatment and loss to follow up, a sample size was determined
to be of 70 subjects (35 subjects in intervention and 35
subjects in control groups. The patients of low and moderate
risk group were included for this study. The risk stratification
was done in accordance to AACVPR Guidelines for Cardiac
Risk Stratification. About 285 patients were screened for study
inclusion and 72 patients who met the criteria and consented
were enrolled in this study (Figure 1).

PROCEDURE: The patients meeting the inclusion
criteria were included for this study after obtaining,
due informed consent. All patients received routine post-operative
management in both the groups which included bronchial
hygiene, breathing exercise and graded ambulation. The usage
of six minute walk test has been tested by many and found
to be suitable for assessment of functional capacity in many
conditions including, cardiac patients. The exercise
capacity of patients was assessed with a six minute walk test
at the time of discharge, as per standard protocol
established. Patient’s exertion level (RPE) was monitored
with Borg’s scale and the distance was noted. The pulse rate
(HR) and oxygen saturation (SpO2) was measured before,
during and after the completion of test. The heart rate, Rate
of Perceived Exertion (RPE) and SpO2 recorded was used as
basis for exercise prescription in phase II rehabilitation. They
were randomized into the intervention or control group as
per computer generated random numbers. Patients of both
the groups received exercise counseling before discharge.

Exercise Intensity: The exercise prescription for the
patients was moderate intensity with 55%–75% of Target
heart rate. The exercises were started with moderate
intensity level i.e. 55% of Target heart rate; over and above
the resting heart rate will be considered as the intensity of
training. The patients were trained with Borg’s RPE method
for intensity monitoring in Phase I, as to be used by the
patients during phase II rehabilitation. The RPE level of mild
to moderate exertion was used in this study.

Exercise Protocol: The patients in intervention group
underwent a set of structured exercise program at outpatient
physiotherapy department 2-3 sessions a week for a period of
12 weeks. They performed low to moderate intensity exercise
training, for at least 20-30 minutes which consisted of walking,
upper and lower extremity movements with 1 to 2.5 kg of
resistance. All sessions had adequate warm up and warm down
for about 15-20 minutes. The total duration of exercise lasted
up to 30-50 minutes. The exercise was supervised and vitals
were monitored through the sessions. The Pulse rate, Blood
Pressure, SpO2, Respiratory rate and Rate of Perceived Exertion
(RPE) were monitored during training. The intensity progression
was based on Target Heart Rate (THR) and RPE over a period
of 12 weeks (Fig. 2).

The patients in control group continued to follow exercise
trained at time of discharge advice at home. The patients, at
home was asked to record in an activity log. After 12 weeks,
patient of both the groups were tested for their changes in
exercise capacity with six minute walk test and all parameters
were noted down.

As most patients were unable to give consent or unable
to maintain regular follow up for outpatient therapy even
though they all showed interest in exercise counseling, the
barriers to Phase II program participation was also noted down
for further analysis.

ANALYSIS AND RESULTS
Among 72 patients enrolled for the study, 24 in
intervention group and 31 in control group completed the
study. The functional capacity was measured by standard six
minute walk test (SMWT) at time of discharge and after 12
weeks of training period was taken up for analysis.

The statistical analysis showed that the patients were
similar in terms of age, number of dyslipidemics, smokers,diabetics and duration of Intensive care Unit (ICU) stay
between the two groups (Table 1). The difference in

Table 1: Baseline Characteristics of the study sample

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Experimental group</th>
<th>Control group</th>
<th>t-value</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Mean)*</td>
<td>58.28</td>
<td>57.77</td>
<td>-0.734</td>
<td>0.466 (P&gt;0.05)</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>22</td>
<td>23</td>
<td>-1.679</td>
<td>0.099 (P&gt;0.05)</td>
</tr>
<tr>
<td>smoking</td>
<td>9</td>
<td>11</td>
<td>-0.151</td>
<td>0.880 (P&gt;0.05)</td>
</tr>
<tr>
<td>Diabetics</td>
<td>20</td>
<td>26</td>
<td>0.052</td>
<td>0.958 (P&gt;0.05)</td>
</tr>
<tr>
<td>ICU stay (Days)*</td>
<td>3.52</td>
<td>3.48</td>
<td>0.122</td>
<td>0.904 (P&gt;0.05)</td>
</tr>
<tr>
<td>Obesity (BMI)</td>
<td>20</td>
<td>19</td>
<td>0.422</td>
<td>0.782 (P&gt;0.05)</td>
</tr>
</tbody>
</table>

*The values are count data unless otherwise stated.
functional capacity measured as SMW distance (in meters) was statistically insignificant at pre and post-training levels, when compared between various risk factors (Table 2, Fig.3 & 4). There was an improvement in both the control and experimental groups at the end of the study period; there was a statistically highly significant improvement in the experimental group than the control group of patients in terms of mean change in functional capacity (SMWDC) compared from the baseline of study (Table 3 & Fig.5).

**Table 2: Pre-Post Training comparison of functional capacity by risk factors**

<table>
<thead>
<tr>
<th>Pre-training</th>
<th>Post-training</th>
<th>t-value</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetic</td>
<td>144</td>
<td>332</td>
<td>0.003*</td>
</tr>
<tr>
<td>Non Diabetic</td>
<td>127</td>
<td>380</td>
<td>1.545#</td>
</tr>
<tr>
<td>Smoker</td>
<td>139</td>
<td>344</td>
<td>0.05*</td>
</tr>
<tr>
<td>Non smoker</td>
<td>143</td>
<td>337</td>
<td>0.538</td>
</tr>
<tr>
<td>Obese</td>
<td>139</td>
<td>309</td>
<td>0.692*</td>
</tr>
<tr>
<td>Non obese</td>
<td>149</td>
<td>357</td>
<td>0.372#</td>
</tr>
</tbody>
</table>

*Pre.Comparison, # Post.Comparison

**Table 3: Pre-Post-Training comparison of functional capacity between Control and Experimental groups**

<table>
<thead>
<tr>
<th>Pre-training</th>
<th>Group</th>
<th>Mean ± SD</th>
<th>t-value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>143 ± 33.29</td>
<td>0.332</td>
<td>0.741</td>
<td></td>
</tr>
<tr>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Experimental</td>
<td>140 ± 28.16</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-training</td>
<td>Control</td>
<td>268 ± 53.45</td>
<td>13.450</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>433 ± 30.90</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DISCUSSION

It is generally accepted that systematic training would result in better results. In the present study the samples were similar in their baseline exercise capacity and their cardiac risk levels. The supervised exercise training group showed statistically significant improvement in their functional capacity than the control group. None of the patients showed any adverse response during exercise training throughout the study period; this study adds to the current body of evidence to develop a feasible simple, tailor-made exercise program in phase II, which could effectively improve the exercise capacity following CABG.

The experimental group patients have shown better improvement than the control group subjects which in accordance to previous studies. About 12 and 3 patients didn’t complete the exercise training in the experimental and the control group respectively. As like in other studies, loss to follow up was a hurdle in effective and complete implementation of the program. The commutation constraints and Lack of patient interest were the common reasons for loss to follow up in majority of patients, which has been noted in previous studies too. Loss to follow up was more in experimental groups shows the need for more emphasis on patient and family education and need for
implementation of insurance coverage for cardiac rehab programs as in western parts of the world.\textsuperscript{5,7} In this study sample had similar characteristics except for number of diabetics was not similar, but the difference was statistically insignificant. Moreover the functional capacity was also not statistically significant in this study, during pre training. However the current result needs to be verified with equal number of diabetics in both the groups. Further the role of multiple risk factors on training outcomes is worth of analyzing. The barriers in implementing the outpatient training program is required to be addressed to maximize patient participation in our Indian setup.

CONCLUSION

The tailor made program results in significant improvement in institution setup than self-monitored exercises, even though both the methods of training were having an impact to improve the functional capacity as measured by the 6MWT distance.

ACKNOWLEDGEMENTS

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