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Improvement of Functional Capacity and Quality of Life by Cardiac Rehabilitation: Case Series

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Abstract

Cardiac rehabilitation (CR) is a long-term program involving prescribed exercise, education, and counseling to mitigate the physiological and psychological impacts of cardiac disease. Despite evidence supporting its effectiveness in reducing mortality rates, CR remains underutilized, particularly among patients with heart failure. This research aims to highlight the importance of CR in improving the quality of life and functional capacity for post-cardiac surgery and heart failure patients. The study involved a series of case illustrations, including patients undergoing aortic valve replacement, coronary artery bypass graft surgery, and congenital heart disease repair. Each patient completed a Phase II rehabilitation program consisting of 12 exercise sessions, with functional capacity measured using the six-minute walk test (6MWT). The results indicated significant improvements in both functional capacity and quality of life, including reductions in depression levels. The findings suggest that CR is highly beneficial in enhancing patients' overall recovery and quality of life, particularly when integrated into standard postoperative care. Given these results, healthcare systems should promote broader access to CR programs to maximize patient outcomes. Additionally, future research should explore long-term benefits and develop personalized CR programs to cater to diverse patient needs.

Keywords: Cardiac Rehabilitation, Post Cardiac Surgery, Heart Failure, Functional Capacity, Quality of Life

INTRODUCTION

Cardiac rehabilitation (CR) services are an integral component in the continuum of care for patients with cardiovascular disease (CVD) (Ardiana, 2021). A Class IA recommendation, referral to CR is 1 of 9 performance measures for secondary prevention established by the American Heart Association and American College of Cardiology after myocardial infarction (MI), percutaneous coronary intervention, coronary artery bypass graft surgery, in the setting of stable angina, symptomatic peripheral arterial disease (i.e., intermittent claudication). Referral to CR is also recommended after heart valve surgery, cardiac transplantation, heart failure (HF). The safety and effectiveness of the traditional medically supervised, center-based CR (CBCR) model are well established, and CBCR is effective in reducing hospital readmissions, secondary events, and mortality in patients with CVD (Thomas et al., 2019).

The most recent EUROASPIRE IV survey was undertaken in 78 centres from 24 European countries. The results of EUROASPIRE survey showed that despite the wealth

of scientific evidence only half of patients were referred to attend a cardiac rehabilitation program and only two-fifths participated in such a programme (Kotseva & Investigators, 2017). Cardiac rehabilitation is underused among patients with heart failure. There are three components that involved to CR, patients factors (time conflicts, lack of motivation, reluctance of change lifestyle, depression), service factors (difficulties with accessibility of programs, little insurance coverage), physician factors (fewer referral from cardiologists, fewer well-trained CR staff, heavy workload of doctors). Those components affected patient fear of readmission (Chun & Kang, 2021); (Bozkurt et al., 2021).

Cardiac rehabilitation (CR) is a long-term program that involves prescribed exercise, education, and counseling to limit physiological and psychological effects of cardiac disease and to enhance the psychosocial and vocational status of the patient (Romelah, 2021). Considering the patient's need to obtain a full and prompt physical recovery after surgery to allow a fast normalization of daily life activities (Kiel, 2011); (Niebauer, 2016).

CR also has an important effect in reducing mortality in patients with HF. According to the Exercise Training Meta-Analysis of Trials in patients with Chronic Heart failure (ExTraMATCH) study, the mortality rate in the CR group was reduced by 35% compared with that in the control group during the 2-year follow-up period (Taylor et al., 2023).

Based on the background provided, the objectives of this research are to analyze the factors contributing to the underutilization of cardiac rehabilitation (CR) services and to assess the impact of CR on reducing mortality and improving patient outcomes, particularly in patients with heart failure. Specifically, the study aims to explore patient, service, and physician-related barriers to CR participation and to evaluate the benefits of CR in enhancing recovery and reducing hospital readmissions.

The benefit of this research is to provide insights into how to increase CR participation rates by addressing the identified barriers, improving patient recovery post-cardiovascular events, and ultimately contributing to the reduction of mortality rates in heart failure patients. These findings could inform healthcare policy and practice to ensure broader access and engagement in cardiac rehabilitation programs, leading to better long-term outcomes for patients with cardiovascular disease.

RESEARCH METHODS

Case Illustration

Case 1

A 36 year old man, came to cardiovascular rehabilitation department of Harapan Kita hospital for cardiac consultation, evaluation and rehabilitation post-surgery. Patient had a history of discharge from successful of aortic valve replacement with a 25 mm SJM medical regent two weeks prior to the consultation. Patient was diagnosed with severe aortic regurgitation vegetation on non-coronary cusp and right coronary cusp, mitral regurgitation mild-moderate and infective endocarditis. The patient complained a presenting symptom of dyspnea one month prior to the admission. The patient has a slight limitation of physical activity, he gets comfortable at rest, and these symptoms were amplified on moderate physical activity. There's no fever, dental caries (+). The patient was referred from Bhakti Asih hospital. The surgical procedure went out successfully and straight-forward. The patient was hopitalized around one month and then discharged from the hospital with warfarin 2 mg o.d, furosemide 40 mg o.d prn, bisoprolol 5 mg o.d, ramipril 5 mg o.d

ECG shows Sinus rhythm, rate 67 x/min, normoaxis, no ST or T segment changes, no ventricular hypertrophy. Chest X-Ray shows a Cardiothoracic ratio of less than 50%,

without any signs of congestions or infections. The latest laboratory findings, PT 16.9 s and INR 1.66

From the echocardiographic finding two weeks after the aortic valve replacement with a 25 mm SJM medical regent surgery, the prosthetic valve is well seated and opens well, there is trace paravalvar leakage, normal global LV systolic function, EF 63%, global normokinetic, eccentric LVH with diastolic dysfunction grade II, reduced RV contractility, there is no pericardial effusion.

At the cardiovascular rehabilitation department, the patient receives a consultation. On the initial 6 minutes walk test (telemetric), the distance was obtained 395 m. The patient receives thorough medical evaluation following a phase II rehabilitation programme containing 12 exercise sessions. Each session started with warm-up followed by ergo cycle, aerobic training and cooling down step. At last 12^{th} session, the final distance on 6 minutes walk test was 447 m with estimation METS 8.64. The patient had increased of distance capacity during 12^{th} session exercise. Specifically, the patient continued to treadmill exercise in seventh session with progression on distance. Then, the patient underwent the cardiac exercise test using treadmill test with bruce protocol. The result is an exercise duration of 08 minutes 01 second, with a maximum systolic blood pressure of 130/80 mmHg, maximum heart rate of 144 bpm (78% maximum HR on BB). The test showed negative ischaemic response, the test was stopped because the patient felt fatigue, with aerobic capacity of 8.9 METs and duke treadmill score of +8.

Table 1. Exercise prescription for the patient

Exercise Type	Aerobic
Frequency	5-7 x/week
Exercise Load (Metts/Watt)	5.3 – 6.2 METs
Exercise Heart Rate (Range)	104 – 117 bpm
Walking (km/30 min)	2.8 – 3.2 km/30 min
Cycling (km/30 min)	6.5 – 8 km/30 min
Re-evaluation	3 – 6 Month
Suggestion	Take medications and exercise regularly

The patient the discharged from the cardiovascular rehabilitation programme and planned to return to the rehabilitation department in 3 to 6 month after the last session. The patient was encouraged to follow the exercise prescription.

Case 2

A 39 year old man, came to cardiovascular rehabilitation department of Harapan Kita hospital for cardiac consultation, evaluation and rehabilitation post discharge from hospital. The patient denied any cardiac symptoms, either dyspnea or chest pain during the consultation. Patient with a history of discharge from hospital 1 week prior to the consultation. Patient was diagnosed with non-ischemic cardiomyopathy, suggesting left ventricular non compaction cardiomyopathy. The patient complained of shortness of breath 1 week prior to the admission. The complaint was accompanied with dyspnea on exertion, paroxysmal nocturnal dyspnea, orthopnea, chest pain, abdominal discomfort, bloating and nausea. Pretibial oedema, fever and cough were denied. The patient was hopitalized around 1 week and then discharged from the hospital with cedocard 5 mg o.d, concor 2.5 mg o.d, lansoprazole 30 mg o.d, spironolactone 25 mg o.d, ubi q 100 mg t.d, rivaroxaban 15 mg o.d, allopurinol 300 mg o.d, dapaglifozin 10 mg o.d, candesartan 16 mg o.d, theragran m o.d, lasix 40 mg b.i.d.

ECG shows Sinus rhythm, rate 88 x/min, normoaxis, downsloping ST depression at V2-V6, no ventricular hypertrophy. Chest X-Ray shows a Cardiothoracic ratio of more than 50%, with sign of congestion (cranialization). Laboratory finding shows elevated

level of NT Pro BNP (777 pg/mL), with elevated liver enzymes (SGOT 178 U/L, SGPT 59 U/L).

From the echocardiographic examination it was found, dilatation on LA, RA, LV, RV. LVH (+) eccentric, LVMI 184 gr/m2, global contractility LV EF 18% (Simpson), reduced RV contractility, TAPSE 1.5 cm, regional wall motion abnormality with mild tricuspid and pulmonary regurgitation.

At the cardiovascular rehabilitation department, the patient receive a consultation. On the initial 6 minutes walk test (telemetric), the distance was obtained 180 m. The patient receives thorough medical evaluation following phase II rehabilitation programme containing 12 exercise session. Each session started with warm-up followed by ergo cycle, aerobic training and cooling down step. The patient had increased until eight session, continued with stagnant of walking distance capacity until 12th session exercise, and had decreased on ergocycle intensity. At last 12th session, the final distance on 6 minutes walk test was 358 m with estimation functional capacity 6.9 METS. Patient is going through heart failure rehabilitation for 3 months.

Table 2. Exercise prescription for the patient

Exercise Type	Aerobic
Frequency	5-7 x/week
Exercise Load (Metts/Watt)	4.1 - 4.8 METs
Exercise Heart Rate (Range)	103-106 bpm
Walking (km/30 min)	2.4 - 2.8 km/30 min
Cycling Weight Training (km/30 min)	4.8 - 6.4 km/30 min
Re-evaluation	3 – 6 Month
Suggestion	Take medications and exercise regularly

Case 3

A 14 year old boy, came to cardiovascular rehabilitation department of Harapan Kita hospital for cardiac consultation, evaluation and rehabilitation post surgery. The patient denied any cardiac symptoms, either dyspnea or chest pain during the consultation. Patient with a history of discharge from succesfull of tetralogy of fallot repair surgery 1 week prior to the consultation. Patient was diagnosed with tetralogy of fallot. The patient complained hemoptysis 5 days prior to the admission. The patient has a slight limitation of physical activity with dyspnea on exertion. Fever, and weight loss were denied. The surgical procedure went out successfully and straight-forward. The patient was hopitalized around 1 week and then discharged from the hospital with bisoprolol 1.25 o.d, ramipril 1.25 mg o.d, furosemide 40 mg o.d

ECG shows Sinus rhythm, rate 100x/min, RAD, ST elevation at lead I and V2-V6, ST depression at V1. Chest X-Ray shows a Cardiothoracic ratio more than 50%, without any signs of congestions or infections.

From the echocardiographic finding two weeks after tetralogy of fallot repair surgery, PE (+) on LV posterior dextra 9-20 mm, good LV function, EF 70%, reduced RV contractility, TAPSE 1.2 cm, residual PS mild, PG 30 mmHg, PR mild, no residual VSD, other valves were in a normal condition.

At the cardiovascular rehabilitation department, the patient receives a consultation. On initial 6 minutes walk test (telemetric), the distance was obtained 300 m. The patient receives thorough medical evaluation following a phase II rehabilitation programme containing 12 exercise sessions. Each session started with warm-up followed by aerobic training and a cooling down step. At last 12th session, the final distance on 6 minutes walk test was 392 m with estimation METS 7.95. The patient had increased of distance capacity during 12th session exercise. Specifically, the patient continued to treadmill exercise in nine session with progression on distance. Then, the patient underwent the cardiac exercise test

using treadmill test with bruce protocol. The result is an exercise duration of 06 minutes 33 second, with a maximum systolic blood pressure of 130/80 mmHg, maximum heart rate of 150 bpm (72% maximum HR on BB). The test showed negative ischaemic response, the test was stopped because the patient felt fatigue, with aerobic capacity of 7.65 METs and duke treadmill score of +7.

Table 3. Exercise prescription for the patient

Exercise Type	Aerobic
Frequency	5-7 x/week
Exercise Load (Metts/Watt)	4.5-5.3 METs
Exercise Heart Rate (Range)	118-130 bpm
Walking (km/30 min)	2.4-2.8 km/30 min
Re-evaluation	3 – 6 Month
Suggestion	Take medications and exercise regularly

The patient was discharged from the cardiovascular rehabilitation programme and planned to return to the rehabilitation department in 3 to 6 months after the last session. The patient was encouraged to follow the exercise prescription and take medications regularly.

Case 4

A 63 year old man, came to cardiovascular rehabilitation department of Harapan Kita hospital for cardiac consultation, evaluation and rehabilitation post surgery. The patient denied any cardiac symptoms, either dyspnea or chest pain during the consultation. Patient with a history of discharge from successful CABG surgery 4 days prior to the consultation. Patient was diagnosed with CAD3VD. The patient complained a presenting symptom of anginal chest pain 6 months prior to the admission. The complaint was accompanied with dyspnea on exertion, slight limitation of physical activity. The patient underwent coronary angiography and said to have occlusion in three coronary arteries. The patient were then planned to have a coronary artery bypass graft surgery (CABG) in the following month. The surgical procedure went out successfully and straight-forward. The patient was hospitalized around 1 month and then discharged from the hospital with bisoprolol 2.5 mg o.d, ramipril 2.5 mg o.d, atorvastatin 20 mg o.d, clopidogrel 75 mg o.d

ECG shows Sinus rhythm, rate 75 x/min, normoaxis, ST elevation at V2-V3, no ventricular hypertrophy. Chest X-Ray shows a Cardiothoracic ratio of more than 50%, without any signs of congestions or infections. Laboratory finding shows elevated platelets (700000 cells/mm^3) and elevated FT 4 level (41.47ng/dL).

From the echocardiographic finding two weeks after the coronary artery bypass graft surgery, good LV systolic function, LVEF 61% (simpson's), global normokinetic, concentric remodeling with grade I diastolic dysfunction without increased LAP, all valves are normal, good RV contractility.

At the cardiovascular rehabilitation department, the patient receives a consultation. On initial 6 minutes walk test (telemetric), the distance was obtained 264 m. The patient receives thorough medical evaluation following a phase II rehabilitation programme containing 12 exercise sessions. Each session started with warm-up followed by ergocycle, aerobic training and cooling down step. At last 12^{th} session, the final distance on 6 minutes walk test was 350 m with estimation METS 5.74. The patient had increased of walking distance capacity until five session exercise. Then decreased on walking distance at 6th session and got stagnant. After that the exercise added with ergocycle training until 12th session, because of stroke history. Then, the patient underwent the cardiac exercise test using ergocycle protocol. The result is an exercise duration of 08 minutes 06 second, with

a maximum systolic blood pressure of 140/80 mmHg, maximum heart rate of 99 bpm (63 % maximum HR on BB). The test showed negative ischaemic response, the test was stopped because the patient felt fatigue, with aerobic capacity of 4.49 METs.

Table 4. Exercise prescription for the patient

Exercise Type	Aerobic
Frequency	5-7 x/week
Exercise Load (Metts/Watt)	2.7-3.1 METs
Exercise Heart Rate (Range)	85-90 bpm
Walking (km/30 min)	1.2-1.6 km/30 min
Cycling Weight Training (watt/30 min)	25-30 watt/30 min
Re-evaluation	3 – 6 Month
Suggestion	Take medications and exercise regularly

The patient was discharged from the cardiovascular rehabilitation programme and planned to return to the rehabilitation department in 3 to 6 months after the last session. The patient was encouraged to follow the exercise prescription and take medications regularly.

Cardiac Rehabilitation has evolved over the past decades from a simple monitoring for the safe return to physical activities to a multidisciplinary approach that focuses on patient education, individually tailored exercise training, modification of the risk factors and the overall well-being of the cardiac patients (Firmana & Anina, 2024). Recent research shows that CR has functions such as mortality reduction, symptom relief, improved exercise tolerance, and the overall psychosocial wellbeing. These interventions include education, counseling and behavioral strategies to promote lifestyle change and modify risk factors (Mampuya, 2012).

Indications of Cardiac Rehabilitation

The generally accepted indications for cardiac rehabilitation include: acute myocardial infarction, stable angina pectoris, coronary artery bypass graft surgery, heart valve repair or replacement, percutaneous transluminal coronary angioplasty and heart transplantation or heart lung transplantation (Mampuya, 2012). Referred to case 1, 3 and 4 the indication of CR is after surgical cardiac procedure (bypass, valvular, CHD, aortic, etc), on case 2 the indication of CR is compensated heart failure (Radi et al., 2019).

Contrandications of Cardiac Rehabilitation

Contraindications to cardiac rehabilitation include unstable angina, decompensated heart failure, complex ventricular arrhythmias, pulmonary arterial hypertension greater than 60 mmHg, intracavitary thrombus, recent thrombophlebitis with or without pulmonary embolism, severe obstructive cardiomyopathy, severe or symptomatic aortic stenosis, uncontrolled inflammatory or infectious pathologies and any musculoskeletal condition that prohibits physical exercise (Radi et al., 2019). Referred to all the case, there is no contraindication.

Benefit of Cardiac Rehabilitation and Exercise Training

Benefits of cardiac rehabilitation and exercise training includes improvement in exercise capacity, lipid profiles, and quality of life. CR also has an effect on reduction in inflammation and indices of obesity (Swain DP, Brawner CA, 2014).

Components of Cardiac Rehabilitation

Phase I or inpatient phase is initiated while the patient is still in the hospital. It consists of early progressive mobilization of the stable cardiac patient to the level of activity required to perform simple household tasks (Mampuya, 2012).

Based on PERKI guidelines, phase II duration program of CR is 1-3 months. Study by Radi et al, in National Cardiovascular Care Unit Harapan Kita phase II duration

program of CR is 1-2 months. In Europe CR phase II duration program 3 to 4 weeks duration are offered. Based on AHA CR phase II duration program 12-36 weeks (Kiel, 2011); (Radi et al., 2019).

Phase III is a lifetime maintenance phase in which physical fitness and additional risk-factor reduction are emphasized. It consists of home-or gymnasium- based exercise with the goal of continuing the risk factor modification and exercise program learned during phase II (Mampuya, 2012).

The American Heart Association, the American College of Cardiology Foundation and the American Association of Cardiovascular and Pulmonary Rehabilitation have outlined the core components of contemporary cardiac rehabilitation and secondary prevention programs and produced guidelines for detection, management and prevention of cardiovascular disease. These core components include patient assessment, exercise training, physical activity counseling, tobacco cessation, nutritional counseling, weight management, aggressive coronary risk-factor management, and psychosocial counselling (Mampuya, 2012).

a. Patient assessment

In order to guide the patient through the different aspects of cardiac rehabilitation, to meet his individual needs and to optimize the benefits. The goal is to insure a safe environment for the patient and to facilitate patient care with minimal risk. Before the exercise training, a symptom limited exercise test is undertaken for prognostic, diagnostic, and therapeutic purposes (Mampuya, 2012).

b. Exercise training

The scientific data clearly establishes that exercise training results in improvements in exercise tolerance. Appropriately prescribed and conducted exercise training is therefore a key component of cardiac rehabilitation. Meyers et al. showed that improvement of 1 metabolic equivalent in functional capacity imparts a 12% reduction in all-cause mortality. Exercise protocols should include not only endurance but also resistance training (treadmills, steppers, weights, rowers, elliptical trainers, exercise bikes, dumbbells etc). High-intensity interval aerobic exercise program and high-calorie-expenditure exercise program are two such modalities (Mampuya, 2012).

Six minutes walk test (the 6MWD) is a test that evaluates the global and integrated responses of all the systems involved during exercise, including the pulmonary and cardiovascular systems, systemic circulation, peripheral circulation, blood, neuromuscular units, and muscle metabolism. Referred to PERKI Guidelines, case 2 exercise is occurred on the next day because the distance is <240 meters and case 1,3,4 exercise is directly occurred (Radi et al., 2019).

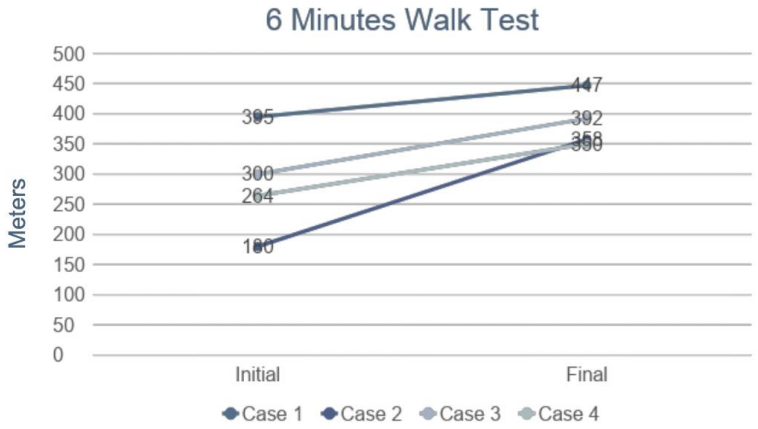


Figure 1. Patient Evaluation in CR

c. Treadmill Test

Treadmill test is ideally to make an exercise prescription because we can find out maximal fitness level, heart rate and blood pressure. We can evaluate ischemic and arrythmia response according to training load. In this case, treadmill test was done in day 12th of the program to evaluate functional capacity (Radi et al., 2019).

d. Physical activity counseling

Regular physical activity has been shown to have many cardiovascular benefits including weight loss, blood pressure reduction, glycaemic control and lipid profile improvements. Most guidelines recommend that exercise should be performed for a minimum of 30 minutes per day at least five days per week and preferably daily, should involve moderately intensive aerobic activity such as brisk walking and should be supplemented by an increase in daily lifestyle activities (e.g., walking breaks at work and gardening) (Mampuya, 2012).

e. Controlling the Risk Factor

Controlling the risk factor with healthy lifestyle or drugs for achieving the target. This step include management of nutrition, weight management, lipid, blood pressure, blood glucose, psychosocial and tobacco cessation (Mampuya, 2012). In this case, nutritional counseling will be carried out by nutritionist doctor.

f. Management of Psychosocial and Professional Issues

Patients with heart disease are often confronted with psychological and social problems that can affect both morbidity and mortality. During cardiac rehabilitation follow-up, patients undergo a routine screening to identify anxiety, depression, substance abuse and familial or other social problems. Medical, psychological and social interventions tailored to individual problems are offered and have been shown to improve outcomes. The INTERHEART Study quite clearly demonstrated that stress was approximately 30% of the population's attributable risk of acute MI. Psychosocial stress affects cardiovascular disease process through the increase in blood pressure, blood glucose, lipid levels and body weight. It also promotes the progression of atherosclerosis, inflammation and endothelial dysfunction (Mampuya, 2012).

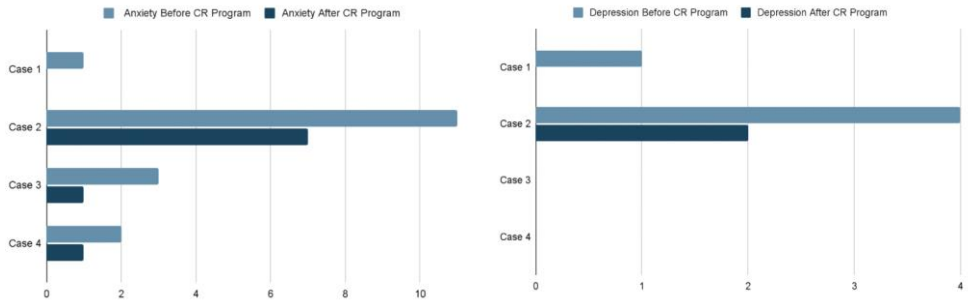
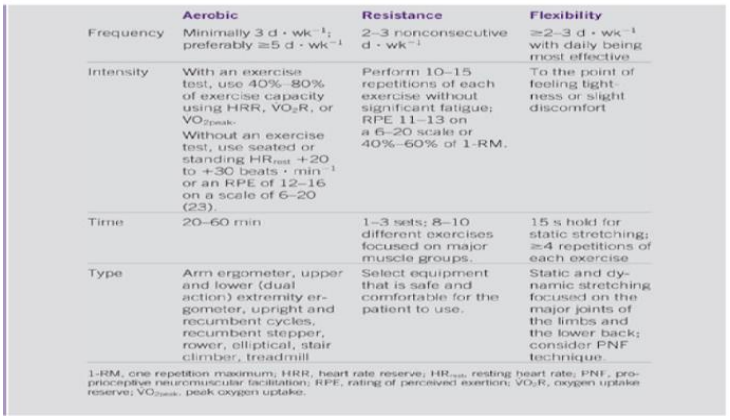


Figure 2. QoL Evaluation Hospital Anxiety and Depression Score

Components of Exercise Training Session (Bakker et al., 2017)

1) Warmed up: at least 5-10 minutes of light to moderate intensity cardiorespiratory and muscular endurance activities
2) Conditioning: at least 20-60 minutes of aerobic, resistance, neuromotor, and or sport activities
3) Cool down: at least 5-10 minutes of light to moderate intensity cardiorespiratory and muscular endurance activities
4) Stretching: at least 10 minutes of stretching exercise performed after the warmed up or cool down phase

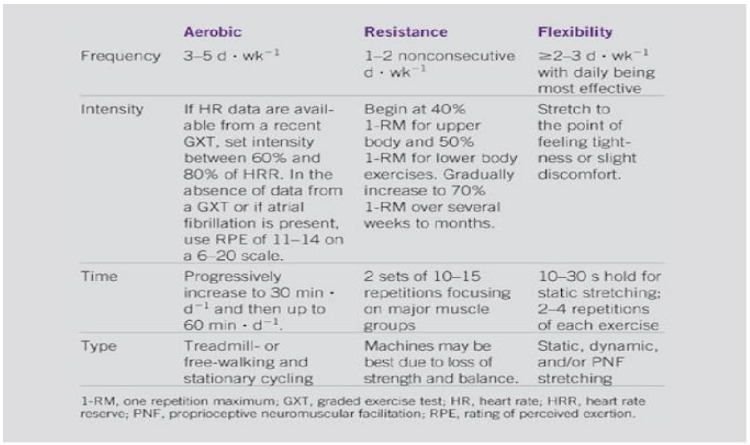


	Aerobic	Resistance	Flexibility
Frequency	Minimally 3 d · wk^{-1}; preferably ≥5 d · wk^{-1}	2–3 nonconsecutive d · wk^{-1}	≥2–3 d · wk^{-1} with daily being most effective
Intensity	With an exercise test, use 40%–80% of exercise capacity using HRR, VO_2R, or VO_{2peak}. Without an exercise test, use seated or standing HR_{rest} +20 to +30 beats · min^{-1} or an RPE of 12–16 on a scale of 6–20 (23).	Perform 10–15 repetitions of each exercise without significant fatigue; RPE 11–13 on a 6–20 scale or 40%–60% of 1-RM.	To the point of feeling tightness or slight discomfort
Time	20–60 min	1–3 sets; 8–10 different exercises focused on major muscle groups.	15 s hold for static stretching; ≥4 repetitions of each exercise
Type	Arm ergometer, upper and lower (dual action) extremity ergometer, upright and recumbent cycles, recumbent stepper, rower, elliptical, stair climber, treadmill	Select equipment that is safe and comfortable for the patient to use.	Static and dynamic stretching focused on the major joints of the limbs and the lower back; consider PNF technique.

1-RM, one repetition maximum; HRR, heart rate reserve; HR_{rest}, resting heart rate; PNF, proprioceptive neuromuscular facilitation; RPE, rating of perceived exertion; VO_2R, oxygen uptake reserve; VO_{2peak}, peak oxygen uptake.

Figure 3. FITT Recommendation for Individuals with CVD (Outpatient CR) (Swain DP, Brawner CA, 2014)

All of the cases are in the outpatient cardiac rehabilitation clinical setting.



	Aerobic	Resistance	Flexibility
Frequency	3–5 d · wk^{-1}	1–2 nonconsecutive d · wk^{-1}	≥2–3 d · wk^{-1} with daily being most effective
Intensity	If HR data are available from a recent GXT, set intensity between 60% and 80% of HRR. In the absence of data from a GXT or if atrial fibrillation is present, use RPE of 11–14 on a 6–20 scale.	Begin at 40% 1-RM for upper body and 50% 1-RM for lower body exercises. Gradually increase to 70% 1-RM over several weeks to months.	Stretch to the point of feeling tightness or slight discomfort.
Time	Progressively increase to 30 min · d^{-1} and then up to 60 min · d^{-1}.	2 sets of 10–15 repetitions focusing on major muscle groups	10–30 s hold for static stretching; 2–4 repetitions of each exercise
Type	Treadmill- or free-walking and stationary cycling	Machines may be best due to loss of strength and balance.	Static, dynamic, and/or PNF stretching

1-RM, one repetition maximum; GXT, graded exercise test; HR, heart rate; HRR, heart rate reserve; PNF, proprioceptive neuromuscular facilitation; RPE, rating of perceived exertion.

Figure 4. FITT Recommendation for Individuals with Heart Failure (Swain DP, Brawner CA, 2014)

Based on case 2, the patient had history of heart failure. The program has been followed for at least 3 months of CR.

Table 5. Cardiac Rehabilitation Response (Bakker et al., 2017)

Improvement of Functional Capacity in 3 Months	Rehabilitation Response Rate
>2.5 ml/kg/min	High Responder
≤2.5 ml/kg/min	Low Responder
≤0 ml/kg/min	Non Responder

Cardiac Rehabilitation in Heart Failure

Latest guidelines recommend concomitant drug treatment for HFrEF patients, the so-called 'four pillars' of heart failure treatment (Taylor et al., 2023). Cardiac rehabilitation is the ideal time and place for implementation and titration of these drugs.

Cardiac Rehabilitation in Children with CHD

Children with "repaired" CHD often have reduced exercise capacity. Residual hemodynamic lesions certainly account for some of this phenomenon. However, it has been observed that children with CHD often lead relatively sedentary lifestyles, perhaps on account of restrictions imposed on them by physicians, parents, teachers, coaches, or the children themselves (Rhodes et al., 2010).

Cardiac Rehabilitation in Post CABG

CR is a comprehensive program, integrating individualized and supervised exercise with education, both important for patients after CABG. It acts in 2 steps: (1) CR promotes a faster recovery from heart surgery in the first weeks after the procedure, which is particularly important for the typical CABG patient, an elderly individual with several comorbidities and limitations; (2) it provides healthy routines, tools, and the knowledge necessary to manage coronary artery disease to be successful in the long term (Niebauer, 2016). In patient after bypass surgery, we have to assess ischemic response and repeat after 3 months for optimization of anti ischemic therapy.

CONCLUSION

Cardiac rehabilitation (CR) has been shown to be highly effective in various cases, including valvular surgery, heart failure, congenital heart disease surgery, and coronary artery bypass surgery, all of which carry a Class I A recommendation. Patients who undergo CR demonstrate significant improvements in functional capacity, as measured by the 6-minute walk test (6MWT), and experience enhanced quality of life, particularly in terms of reduced depression levels. Moreover, cardiac rehabilitation is universally covered, allowing its benefits to extend beyond surgical cases to include heart failure patients. The primary advantages of CR include improved functional capacity, enhanced fitness levels, and an overall better quality of life for patients with cardiovascular conditions. To further maximize the benefits of cardiac rehabilitation, it is recommended that healthcare systems continue to promote the universal accessibility of CR programs, particularly for non-surgical patients, such as those with heart failure. Future initiatives should focus on improving patient referral rates by addressing physician-related barriers, such as workload and training, and mitigating patient factors like lack of motivation and time constraints. Additionally, future research could explore the long-term effects of CR on psychological well-being and investigate the development of personalized CR programs to meet the unique needs of different patient populations. Expanding tele-rehabilitation and home-based CR models may also offer more flexible options for patients, ultimately leading to increased participation and better overall outcomes..

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