Cardiac Rehabilitation in Heart Failure

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Abstract

Heart failure is a condition which debilitates the patient in terms of physical activity and activities of daily living. In a person with Heart Failure (HF), the heart is unable to cope up to the demands of the tissues, resulting in dyspnea. Dyspnea on performing activities of daily living, increases the fear of performing any more activities. However, recently it has been observed that exercises can be performed through a structured, supervised cardiac rehabilitation program safely and effectively. It not only improves the activity tolerance but also improves the quality of life. In this article, the benefits associated with exercise training, exercise prescription and the safety concerns during cardiac rehabilitation of heart failure patients have been discussed.

Keywords: Cardiac rehabilitation, exercise, heart failure, exercise prescription, dyspnea

Introduction

Heart failure (HF) is a complex clinical syndrome that can result from any structural or functional cardiac disorder that impairs the ability of the ventricle to fill with or eject blood. It is characterized by specific symptoms, such as dyspnea and fatigue, and signs, such as those related to fluid retention. Heart failure is largely a clinical diagnosis that is based upon a careful history and physical examination.

In patients with heart failure (HF), the heart is unable to cope up to the demands of the tissues, resulting in dyspnea, may be at rest or exercise-induced. One of the first reason to seek medical help in these patients is inability to perform exercise or activities without discomfort.

Cardiac Rehabilitation enables the patients to improve the quality of life by improving the activity tolerance and improving the exercise capacity. Thus, the role of cardiac rehabilitation in these patients is cardinal.

Classification and Pathophysiology of Heart Failure

Patients with heart failure are divided into two major categories namely:

1. Heart Failure with reduced Ejection Fraction (HFrEF), is characterized by a normal LVEF, normal LV end-diastolic volume, and abnormal diastolic function, often with LV concentric remodeling or hypertrophy, but sometimes with normal ventricular geometry. Most authorities currently define HFpEF by Left Ventricular Ejection Fraction (LVEF) ≥50 percent.
2. Heart Failure with preserved Ejection Fraction (HFpEF), is characterized by more profound abnormalities in systolic function than what are seen in HFpEF, usually with progressive chamber dilation and eccentric remodeling. HFrEF is now most commonly defined by LVEF ≤40 percent. [1]

There are two major cardiac mechanisms by which this can occur.

1. Systolic dysfunction (impaired cardiac contractility)
2. Diastolic dysfunction (abnormal cardiac relaxation, stiffness or filling)

The exercise capacity is affected even in patients with mild heart failure. Although the cardiac output may be relatively normal at rest, it is usually unable to increase adequately with even mild exertion.

Previously, it was thought that the cardiac dysfunction was solely responsible for exercise limitation in patients with HF. However, drugs that improve cardiac output may not be enough to improve exercise tol-

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erance. [2–4]

Thus, factors in addition to the low cardiac output and reduced skeletal muscle blood flow contribute to poor exercise tolerance and fatigue. Also, significant biochemical and functional abnormalities have been reported in skeletal muscles of patients with heart failure, thus playing a large role in the exercise intolerance [5,6] (Table 1).

Table 1

Sr. No.	Factors affecting exercise capacity in Heart failure.
1	Myocardial dysfunction
2	Impaired inotropic and chronotopic response to catecholamines.
3	Systolic dysfunction leading to decreased blood flow to muscles.
4	Skeletal muscle cell apoptosis and impaired generation of ATP by mitochondria.

In the past, concerns have been raised regarding exercise training in heart failure patients as it could potentially cause an exacerbation of heart failure and/or an adverse cardiovascular or neurohemoral event. Recent evidence confirms the safety and efficacy of cardiac rehabilitation in patients with heart failure. Benefits of rehabilitation have been discussed in the sections below. [7]

Benefits

1. Improving exercise capacity

Regular exercise training helps in improving both submaximal as well as the maximal exercise capacity. The improvement is assessed by exercise duration and more importantly, improved oxygen utilization and hence peak VO2. Various changes in the haemodynamics, the neurohumoral changes, lead to the increase in oxygen uptake during the exercise. The improvement in the skeletal muscle metabolism and decreased ventilation also correlate with increase in Peak VO2. [8]

2. Haemodynamics

Exercise training reduces resting sympathetic tone and increases resting vagal tone. This change in the sympathetic and parasympathetic balance is associated with lower heart rate, blood pressure, minute ventilation at rest and also during peak exercise. Hence it restores autonomic cardiovascular control towards normal. [8,9,10] Neurohumoral activity and resting levels of angiotensin, aldosterone, vasopressin, and natriuretic peptide are reduced with exercise training. [9,11,12] These changes permit the patient to perform their daily activities with fewer symptoms and lesser disability. [7]

3. Decreased Ventilatory Threshold to Raised Lactate Levels

In patients with heart failure, there is excessive increase in blood lactate and reduction in Peak VO2 resulting in a disproportionate increase in ventilation at a submaximal workload.

Exercise training has the potential to delay the lactate accumulation during the exercise and improve the ventilation perfusion ratio in the lung. This reduces the ventilatory response and thus helps in decreasing perceived dyspnea. [8]

4. Effect on Skeletal Muscle

Increase muscle oxidative capacity and reduction in the oxidative stress is seen with exercise training. Oxygen utilization is reduced with increased activity of oxidative enzymes and an increase in mitochondrial content in patients with HFrEF. [11]

These changes may improve the peak VO2 and delay the onset of anaerobic metabolism. Patients with the worse function seem to benefit the most. This observation is encouraging and should be shared with patients who may be hesitant or afraid. [10] In addition, exercise training also reduces plasma levels of pro-inflammatory cytokines, including tumor necrosis factor alpha (TNF-α) and interleukin-6 and their soluble receptors; and apoptotic mediators. This results in improvement of the muscle function.

5. Myocardial Adaptation

Improvement in exercise capacity after exercise training is mainly related to the peripheral adaptations. However, there are favorable effect on myocardium as well.

Improvements in cardiac output and exercise capacity with exercise may be related to improvements in diastolic function as manifested by increase in peak early diastolic filling rate of the LV at rest and during exercise. [13]

6. Impact on Functional Status and Quality of Life

Exercise-based cardiac rehabilitation has a beneficial effect on functional status and health-related quality of life in patients with HF as demonstrated by randomized trials comparing one to six months of exercise training with no exercise program. [1,6,7,14,15] The beneficial effects of exercise may be seen with high or low levels of training.

The benefits of cardiac rehabilitation were illustrated by an individual participant data meta-analysis that included 13 randomized trials with a total of 3990 patients with HF (97 percent with LVEF <45 percent) comparing exercise-based cardiac rehabilitation

(for three weeks or more) with a no exercise control group [6]:

- At 12 months follow-up, there were significant improvements in six-minute walk test (mean increase 21.0 m) and Minnesota Living with HF score (mean improvement 5.9). In the 7 trials assessing peak VO2, this was nominally increased with exercise training (mean 1.01 ml/kg per minute).
- Results were also similar for LVEF <45 percent and LVEF ≥45 percent.

In the largest included trial, HF-ACTION, 2331 patients with reduced LVEF (≤35 percent) and NYHA class II to IV HF were randomly assigned to a formal exercise program versus a control program. [14] The peak improvement in peak VO2 was modest, although statistically significant both at 3 and 12 months, as was the improvement in six-minute walk distance at three months. The six-minute walk improvement at three months was attenuated at 12 months. In addition, there was a significant improvement in health status as measured by the Kansas City Cardiomyopathy Questionnaire, which occurred early and remained for the duration of the trial. [16]

7. Effect on Depression

Depression is common in patients with heart failure. It has an adverse effect on the prognosis. [17,18] In the HF-ACTION trial in which the Beck Depression Inventory II was administered to 2322 patients. [19] At entry, 28 percent of patients had scores of 14 or higher, which is considered clinically significant. Exercise training modestly improved the depression scores compared with the control group at three months with a smaller response at one year.

Based on the above evidence, rehabilitation may have a role in reducing HF related depression.

8. Monitoring of Physical Condition

In addition to providing direct benefits, the closer monitoring of symptoms afforded by a supervised program may allow detection and treatment of worsening HF prior to those symptoms necessitating an emergency department visit or an admission, particularly if the cardiac rehabilitation team communicates with patients' other care teams.

The frequent contact with the rehabilitation team may also identify medication issues such as side effects and questions about meals with medications, all of which impact adherence.

Indications

In our experience patients who may benefit from cardiac rehabilitation are:

1. Stable New York Heart Association (NYHA) functional class II to III HF with reduced ejection fraction (left ventricular ejection fraction [LVEF] ≤40 percent; HFrEF).
2. Stable NYHA functional class II to III HF with preserved ejection fraction (LVEF ≥50 percent; HFpEF) or mid-range ejection fraction (LVEF 41 to 49 percent).

Presently, there are not enough data at present to recommend cardiac rehabilitation for patients with class IV HF. However in our experience, a cardiac rehabilitation consult will be helpful in teaching energy conservation techniques and help in teaching breath pacing while doing basic Activities of Daily Living.

Components of Cardiac Rehabilitation

The Cardiac Rehabilitation team consists of Cardiologist, Physiotherapist, Nutritionist, Psychologist, Nurse and a coordinator. The whole team works together with the patient to improvise the health and clinical condition of the patient.

A cardiac rehabilitation program for patients with HF should include all components of such programs, including medical evaluation and baseline patient assessment, education concerning medication adherence, risk factor reduction including dietary recommendations, psychosocial support, exercise training and physical activity counseling. [7]

Exercise Prescription

Exercise prescription is based on the FITT (Frequency, Intensity, Type and Time or duration) principle.

A typical exercise prescription:

Frequency	3 days a week, (Structured, center based, supervised training program)
Intensity	55-70% of Heart Rate Reserve (Heart Rate Reserve= Maximum heart rate- Resting heart rate) or RPE of 15-17.
Duration	Each session about 30-40 minutes.
Type of exercise	Aerobic exercises, resistance exercise, inspiratory muscle training.

Initially, supervised exercise program helps to familiarize the patients with the sense of activity, improvement in quality of life and provides them with the safety limits while performing the exercises. Additionally, a center based rehabilitation program helps in getting a peer support, thereby improving the

motivation for performing the exercises with less fear.

The center based rehabilitation program must provide a telemetry monitoring during the sessions to monitor any adverse cardiac events during the exercise and provide a safety limit of exercise to the patient.

An unsupervised home training program can overlap with supervised sessions and gradually become the preferred choice once the supervised program is complete. [14]

Exercise training in patients with compensated HFrEF reduces total and HF-related hospitalizations, improves exercise tolerance and health-related quality of life, and reduces symptoms of depression. [14]

Exercise training in patients with compensated HFpEF improves exercise tolerance and health-related quality of life. [7,20]

Types of Exercise

1. Aerobic Exercises

In cardiac rehabilitation programs for patients with HF, evidence and experience is greatest for aerobic exercises. Hence aerobic training in these patients is dominant form of exercise. There are variety of aerobic training modalities like walking, cycling, cycle ergometer, arm ergo-meter, etc which can be used. These activities may be interspersed with periods of rests if required. Progression of these exercises can be done by increasing the duration gradually and then the intensity of exercises.

2. Resistance Training

Evidence for resistance training is limited. This type of training may help in patients who have lost their muscle mass. Resistance training needs to be individualized depending on the activity level and the goals of the patient. They need to be closely monitored for symptoms and blood pressure. It's important to avoid Valsalva maneuver which may increase vascular resistance. This can be done by teaching the patient to breathe during a resistance training activity.

3. Inspiratory Muscle Training

Preliminary evidence suggests that inspiratory muscle training may improve exercise capacity in patients with chronic HF. Respiratory muscle weakness and deconditioning may worsen exercise tolerance and quality of life in patients with HF. Respiratory muscle training, or inspiratory muscle training, has improved muscle strength and endurance in patients with chronic obstructive pulmonary disease.

Engaging the family in supporting the patient helps to improve compliance of these patients.

In the digital era, smartphone technology may be helpful both to monitor the patient's activity and to assess changes in function. Technology tools may enhance patient participation in increased activity at home. More research is needed to assess the long-term benefits of technology as a substitute for center-based cardiac rehabilitation. [21]

Telerehabilitation was developed as a means of providing cardiac rehabilitation with remote electrocardiographic monitoring and telephonic communication with a medical team. This is particularly for patients who live far from rehabilitation centers or who have difficulty with transportation. [22] Patients are provided with exercise equipment to continue the program at home and used diaries, phone calls, and pulse monitors to track adherence. [14,23]

Telehealth has become a more convenient method of patient visits in recent times. However in patients with heart failure the safety of exercise needs to be established before adapting this approach for rehabilitation. Further studies are needed to compare telerehabilitation with on-site, in-person visits. Health insurance coverage is an important factor for implementation.

Conclusion

To summarize, Cardiac rehabilitation does play an important role in management of patients with heart failure. Patients with both HFrEF and HFpEF benefit with cardiac rehabilitation to improve their health status.

For patients who are unable to attend formal cardiac rehabilitation programs, a home program is an alternative option. Cardiac rehabilitation could be offered as a multidisciplinary approach where every member of the team contributes to improve the patients' outcomes. However, program needs to be individualized for each patient depending on the clinical condition and individual goals of patients. With a more homogeneous approach and further evidence in this regard will help in increased implementation of HF rehabilitation programs even at grass root level.

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References:

1. Piña IL, Apstein CS, Balady GJ, et al. Exercise and heart failure: A statement from the American Heart Association Committee on exercise, rehabilitation, and prevention. *Circulation. 2003*;107(8):1210-1225. doi:10.1161/01.cir.0000055013.92097.40
2. Wilson JR, Martin JL, Ferraro N. Impaired skeletal muscle nutritive flow during exercise in patients with congestive heart failure: role of cardiac pump dysfunction as determined by the effect of dobutamine. *Am J Cardiol. 1984*;53(9):1308-1315. doi:10.1016/0002-9149(84)90085-7
3. Kugler J, Maskin C, Frishman W H, Sonnenblick E H, LeJemtel T H. Regional and systemic metabolic effects of angiotensin-converting enzyme inhibition during exercise in patients with severe heart failure. *Circulation. 1982*;66(6):1256-1261. doi:10.1161/01.CIR.66.6.1256
4. Kokkinos PF, Choucair W, Graves P, Papademetriou V, Ellahham S. Chronic heart failure and exercise. *Am Heart J. 2000*;140(1):21-28. doi:10.1067/mhj.2000.106916
5. Ades PA, Keteyian SJ, Balady GJ, et al. Cardiac rehabilitation exercise and self-care for chronic heart failure. *JACC Heart Fail. 2013*;1(6):540-547. doi:10.1016/j.jchf.2013.09.002
6. Taylor RS, Walker S, Smart NA, et al. Impact of Exercise Rehabilitation on Exercise Capacity and Quality-of-Life in Heart Failure: Individual Participant Meta-Analysis. *J Am Coll Cardiol. 2019*;73(12):1430-1443. doi:10.1016/j.jacc.2018.12.072
7. Ponikowski P, Voors AA, Anker SD, et al. 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failureThe Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC)Developed with the special contribution of the Heart Failure Association (HFA) of the ESC. *Eur Heart J. 2016*;37(27):2129-2200. doi:10.1093/eurheartj/ehw128
8. Liu Jun-Li, Irvine Scott, Reid Ian A., Patel Kaushik P., Zucker Irving H. Chronic Exercise Reduces Sympathetic Nerve Activity in Rabbits With Pacing-Induced Heart Failure. *Circulation. 2000*;102(15):1854-1862. doi:10.1161/01.CIR.102.15.1854
9. Cipriano G, Cipriano VTF, da Silva VZM, et al. Aerobic exercise effect on prognostic markers for systolic heart failure patients: a systematic review and meta-analysis. *Heart Fail Rev. 2014*;19(5):655-667. doi:10.1007/s10741-013-9407-6
10. Braith RW, Welsch MA, Feigenbaum MS, Kluess HA, Pepine CJ. Neuroendocrine activation in heart failure is modified by endurance exercise training. *J Am Coll Cardiol. 1999*;34(4):1170-1175. doi:10.1016/s0735-1097(99)00339-3
11. Hambrecht R, Niebauer J, Fiehn E, et al. Physical training in patients with stable chronic heart failure: effects on cardiorespiratory fitness and ultrastructural abnormalities of leg muscles. *J Am Coll Cardiol. 1995*;25(6):1239-1249. doi:10.1016/0735-1097(94)00568-B
12. Belardinelli R, Georgiou D, Cianci G, Purcaro A. Effects of exercise training on left ventricular filling at rest and during exercise in patients with ischemic cardiomyopathy and severe left ventricular systolic dysfunction. *Am Heart J. 1996*;132(1 Pt 1):61-70. doi:10.1016/s0002-8703(96)90391-9
13. Newhouse A, Jiang W. Heart failure and depression. *Heart Fail Clin. 2014*;10(2):295-304. doi:10.1016/j.hfc.2013.10.004
14. Smart N, Marwick TH. Exercise training for patients with heart failure: a systematic review of factors that improve mortality and morbidity. *Am J Med. 2004*;116(10):693-706. doi:10.1016/j.amjmed.2003.11.033
15. Experience from controlled trials of physical training in chronic heart failure. Protocol and patient factors in effectiveness in the improvement in exercise tolerance. European Heart Failure Training Group. *Eur Heart J. 1998*;19(3):466-475. doi:10.1053/euhj.1997.0736
16. Flynn KE, Piña IL, Whellan DJ, et al. Effects of exercise training on health status in patients with chronic heart failure: HF-ACTION randomized controlled trial. *JAMA. 2009*;301(14):1451-1459. doi:10.1001/jama.2009.457
17. Coats AJ, Adamopoulos S, Radaelli A, et al. Controlled trial of physical training in chronic heart failure. Exercise performance, hemodynamics, ventilation, and autonomic function. *Circulation. 1992*;85(6):2119-2131. doi:10.1161/01.cir.85.6.2119
18. Fan H, Yu W, Zhang Q, et al. Depression after heart failure and risk of cardiovascular and all-cause mortality: a meta-analysis. *Prev Med. 2014;*63:36-42. doi:10.1016/j.ypmed.2014.03.007
19. Blumenthal JA, Babyak MA, O'Connor C, et al. Effects of exercise training on depressive symptoms in patients with chronic heart failure: the HF-ACTION randomized trial. *JAMA. 2012;*308(5):465-474. doi:10.1001/jama.2012.8720
20. Pandey A, Parashar A, Kumbhani D, et al. Exercise training in patients with heart failure and preserved ejection fraction: meta-analysis of randomized control trials. *Circ Heart Fail. 2015*;8(1):33-40. doi:10.1161/CIRCHEARTFAILURE.114.001615
21. Clark AL, Poole-Wilson PA, Coats AJ. Exercise limitation in chronic heart failure: central role of the periphery. *J Am Coll Cardiol. 1996*;28(5):1092-1102. doi:10.1016/S0735-1097(96)00323-3
22. Piotrowicz E, Piotrowicz R. Cardiac telerehabilitation: current situation and future challenges. *Eur J Prev Cardiol. 2013*;20(2 Suppl):12-16. doi:10.1177/2047487313487483c
23. Keteyian SJ, Leifer ES, Houston-Miller N, et al. Relation between Volume of Exercise and Clinical Outcomes in Patients with Heart Failure. *J Am Coll Cardiol. 2012;*60(19):1899-1905. doi:10.1016/j.jacc.2012.08.958.