Exercise based cardiac rehabilitation in chronic heart failure

Frances M Wise
MBBS, PhD, FAFRM(RACP), is Senior Rehabilitation Physician, Cardiac Rehabilitation Unit, Caulfield General Medical Centre, Victoria.
f.wise@cgmc.org.au

People with chronic heart failure often present to their general practitioner with questions about their participation in cardiac rehabilitation programs. This article outlines the risks and benefits of such programs.

Chronic heart failure (CHF) is a leading cause of morbidity in the industrialised world.[1] It can be defined as 'a complex clinical syndrome with typical symptoms (eg. dyspnoea, fatigue) that can occur at rest or on effort, and characterised by objective evidence of an underlying structural abnormality or cardiac dysfunction that impairs the ability of the ventricle to fill with or eject blood (particularly during exercise)'.[1] Clinical improvement with treatment further strengthens the diagnosis of CHF.

Incidence, prevalence and prognosis

Approximately 1.5–2.0% of the Australian population is affected by heart failure, with 20 000 new cases diagnosed each year.[1] The incidence and prevalence increases with age, from 1% in patients aged 50 years to over 50% in those aged 85 years or over.[2,3]

The long term prognosis is poor: half of those diagnosed with CHF will die within 4 years and the 1 year mortality rate in severe heart failure is over 50%.[4,5] Predictors of poor prognosis in CHF are summarised in *Table 2*. The most common causes of CHF are ischaemic heart disease (over half of new cases), hypertension (two-thirds of cases) and idiopathic dilated cardiomyopathy (~5–10% of cases).[1]

Diagnosis of CHF

The criteria for diagnosis are:

- symptoms of heart failure at rest or during exercise (eg. dyspnoea, fatigue, oedema exercise intolerance), and
- objective evidence (preferably by echocardiography) of cardiac dysfunction (systolic and/or diastolic) at rest and in cases where the diagnosis is in doubt, and
- response to treatment directed toward heart failure.[5]

The New York Heart Association (NYHA) classification of heart failure is presented in *Table 1*.

Studies show diagnosis by clinical means alone is often inaccurate[5,6] particularly in women, the elderly and the obese. The National Heart Foundation of Australia, the Cardiac Society of Australia and New Zealand, the European Society of Cardiology, and the National Institute for Clinical Excellence in the United Kingdom recommend that all patients clinically suspected of having CHF undergo echocardiography to formally diagnose the condition.[1,5,7]

Pathogenesis

Heart failure is characterised by reduced exercise tolerance and poor quality of life. This is due in part to an enlarged and ineffective myocardium unable to maintain sufficient cardiac output to meet tissue demands. In addition, the mechanisms underlying peripheral deconditioning in CHF (characterised by skeletal muscle atrophy with associated early fatigability and decrease in strength) include:

- impairment of skeletal muscle blood flow (including abnormalities in vasodilatation)
- impairment of skeletal muscle metabolism
- elevation of plasma cytokines leading to muscle catabolism
- reduced percentage of type 1 (slow twitch) muscle fibres in skeletal muscle
- increased dependence on anaerobic pathways for energy production, and
- activation of the renin angiotensin and sympathetic systems leading to a rise in resting heart rate.[8–12]

Cardiac rehabilitation for CHF patients

Historically, patients with CHF were excluded from cardiac rehabilitation programs as it was thought that exercise might cause decompensation in an already weakened

heart.[9] Gradually evidence emerged that supported the benefits of exercise and in 1994 guidelines were published recommending the routine use of a supervised rehabilitation exercise program.[13] Subsequent studies have demonstrated the general benefits of cardiac rehabilitation in this group,[14] and supervised exercise programs are now recommended for all CHF patients as part of nonpharmacological management (*Table 3*).[15]

What is cardiac rehabilitation?

Cardiac rehabilitation units offer supervised exercise and are involved in secondary prevention of cardiovascular disease via education, counselling and behavioural interventions to promote lifestyle change and modify cardiac risk factors. Cardiac rehabilitation is typically provided by a multidisciplinary team of medical, nursing and allied health staff. The core components of a cardiac rehabilitation program are presented in *Table 4*.

In coronary heart disease patients, cardiac rehabilitation is known to reduce rates of mortality and further cardiac events and to improve physical and psychosocial functioning, including earlier return to work. Evidence now exists that cardiac rehabilitation also benefits CHF patients in terms of exercise capacity and health related quality of life.[9,14]

Who should have rehabilitation?

The *Best practice guidelines for cardiac rehabilitation and secondary prevention*[15] state that: 'All patients with heart failure should be enrolled in an exercise program as a part of comprehensive rehabilitation, including before and after transplantation'. In practice, however, cardiac rehabilitation (of which exercise training is an integral part) is typically offered to patients with stable NYHA class II or III heart failure. It is now generally accepted that exercise training – specifically aerobic exercise training in a supervised hospital based setting – is safe in such patients, but as yet no research evidence

Table 1. New York Heart Association classification of heart failure

Class I (mild)	No limitation on physical activity. Ordinary physical activity does not cause undue fatigue, palpitation, or dyspnoea (shortness of breath)
Class II (mild)	Slight limitation of physical activity. Comfortable at rest, but ordinary physical activity results in fatigue, palpitation, or dyspnoea
Class III (moderate)	Marked limitation of physical activity. Comfortable at rest, but less than ordinary activity causes fatigue, palpitation, or dyspnoea
Class IV (severe)	Unable to carry out any physical activity without discomfort. Symptoms of cardiac insufficiency at rest. If any physical activity is undertaken, discomfort is increased

Table 2. Predictors of outcome in CHF[1]

Demographic and historical	Clinical	Electrophysiologic	Functional/exertional	Blood	Central haemodynamic
Advanced age	**Persistent low blood pressure**	Broad QRS	**VO2 max** (max oxygen consumption mL/kg/min) <10–14	**High serum brain natriuretic peptide**	Low left ventricular ejection fraction
Resuscitated sudden death	**NYHA functional class III-IV**	Low heart rate variability	High VE/VCO2 ratio	**Low serum sodium**	Impaired right ventricular function
Diabetes	Low body mass index	Complex ventricular rhythms	Low 6 minute walking ability	**High serum creatinine**	Low cardiac index
Coronary aetiology	Ventilatory rhythm and rate disturbances	T wave alternans		**High serum bilirubin**	High left ventricular filling pressure
Ethnicity	High heart rate			Anaemia	Restrictive mitral filling pattern
	High heart rate			High serum norepinephrine	Increased left ventricular volumes
				High serum troponin	Cardiothoracic ratio
				High serum uric acid	

VE = ventilation volume per minute, VCO2 = ventilation of CO2

Strong predictors are indicated in bold

recommends exercise training in unstable heart failure or those with NYHA class IV.[14]

Even for patients with stable heart failure, for whom cardiac rehabilitation is potentially appropriate, there are contraindications to exercise training (*Table 5*). Therefore, it is recommended that all patients be reviewed by a cardiologist before commencement of an exercise training program.

Current recommendations

The ideal exercise prescription should be based on measurement of a patient's maximum oxygen consumption during exercise (VO2 max). Traditionally this has been calculated using maximal exercise tests on either a treadmill or a bicycle, with encouragement to exercise to exhaustion. The protocols used can estimate oxygen consumption at specific workloads. From this, exercise intensity to be used in exercise training can be determined.

For cardiac rehabilitation units not equipped to perform maximal exercise tests, submaximal tests (eg. '6 minute walk test'[16]) may be used to guide exercise prescription, and the Borg Rating of Perceived Exertion[17] can be used to determine and monitor appropriate exercise intensity. In CHF patients, exercise intensities corresponding to rating of perceived exertion of 12–13 (somewhat hard) have been reported to be well tolerated by the stable patient.[9]

Exercise training can be administered as steady state or interval training (*Table 6*). Aerobic exercise sessions most commonly involve walking or stationary exercise bikes (cycle ergometer). Stationary bikes allow exercising at very low workloads and continuous monitoring of heart rate, rhythm and blood pressure.Walking allows for a wide range of workloads and is thus suitable for patients at a broad range of exercise tolerance. Regardless of modality, exercise sessions should include an adequate warm up period, usually 10–15 minutes, which may need to be longer in the most debilitated patients. A cool down period is also advised. Exercise training usually occurs 2–3 times per week with walking at home encouraged on nonrehabilitation days, although patients who develop exhaustion after training may need a day of rest between sessions.

Strength training can offer the opportunity to strengthen individual muscle groups in both the upper and lower body. Based on recent scientific evidence, it is safe in CHF patients.[18] Small free weights (0.5–2 kg), elastic bands, or repetitive isolated muscle training can be used. Combined aerobic and resistance training administered as a circuit program can increase skeletal muscle strength and exercise tolerance (peak VO2), thereby improving the patient's physical capacity for the tasks of daily living.[18]

Pulse, blood pressure and symptoms should be monitored before, during and after exercise. Exercise should be terminated if there is an acute decrease in blood pressure, onset of angina, significant dyspnoea and fatigue, a feeling of exhaustion, and/or serious exercise induced rhythm disorders.[8]

No significant deleterious effects on cardiac function result from regular exercise.[9] In a meta-analysis of heart failure research, there were no reports of deaths directly related to exercise during more than 60 000 patient hours of exercise training.[19] However, certain types of exercise should be avoided by people with CHF. Jogging is not advisable due to the oxygen consumption required at even slow speeds. Swimming should be avoided because of the acute volume loading of the left ventricle and the increased pulmonary capillary wedge pressure resulting from hydrostatic pressure when immersed in water. Outdoor cycling and overcoming environmental stress factors (eg. slopes, head winds) require significant oxygen consumption and should only be undertaken by long term stable NYHA class I or II patients.[9]

Specific benefits

The benefits of exercise training in patients with CHF include improved VO2 max and exercise tolerance.[9] Evidence suggests that most improvement is due to the effects of training on

Table 3. Nonpharmacological management of CHF[1]

General measures

- Education of patient and family
- Weight monitoring (daily weigh) and patients to consult their doctor if their weight increases by more than 2 kg in a 2 day period
- Control of sodium intake (<2 g/day)
- Fluid restriction (around 1.5 L/day; 1 L/day if severe CHF)
- No more than 2 standard alcoholic drinks per day (none in alcoholic cardiomyopathy)
- Weight reduction in obese patients
- Smoking cessation
- Limit travel to high altitudes or very hot/humid places
- Education regarding medications to avoid (eg. NSAIDS, corticosteroids)
- Suspected sleep apnoea (which frequently co-exists with CHF) referred to sleep physician
- Vaccination against influenza and pneumococcal disease
- No more than two cups of caffeinated beverages per day is recommended
- Pregnancy should be avoided
- Postdischarge follow up through a home visit or specialist CHF clinic is recommended to prevent clinical deterioration

Rest, exercise and exercise training

- Patients who have an acute exacerbation or are clinically unstable should have a period of bed rest until their condition improves
- Regular physical activity is recommended
- All patients should be referred to a specially designed physical activity program (eg. cardiac rehabilitation) if available

peripheral circulation and skeletal muscle rather than on the heart itself.[15] Exercise training can:

- partially reverse activation of the neurohormonal system and reduce levels of pro-inflammatory cytokines[20]
- improve the ratio of type 1 and type 2 muscle fibres which reduces skeletal muscle fatigability[20]
- improve skeletal muscle metabolism[9]
- increase blood flow within the active skeletal muscles,[8] and
- reduce dependence on anaerobic metabolism.[9]

The net functional result of such improvements is an increase in exercise duration and physical work capacity, as well as a reduction in mortality, morbidity and hospital admissions.[20] Evidence suggests that exercise training in CHF patients can increase exercise capacity by 15%, improve NYHA functional class,[9] reduce mortality by 35%,[8] and improve quality of life. As patients develop greater exercise tolerance, they experience less fatigue and dyspnoea and become more comfortable performing activities of daily living. This is turn leads to increased independence, less chronic illness behaviour and depression, and an improvement in general sense of wellbeing.[9]

Table 4. Core components of a cardiac rehabilitation program

Component	Examples of interventions
Patient assessment	History, examination and development of a care plan
Nutritional counselling	Develop a combined diet, exercise, and behavioural program designed to reduce total caloric intake, maintain appropriate intake of nutrients and fibre and increase energy expenditure
Lipid management	Provide nutritional counselling, weight management, exercise, alcohol moderation and monitor drug treatment with primary health care provider
Hypertension management	Monitor and provide lifestyle modifications including exercise, weight management, moderate sodium restriction, alcohol moderation, smoking cessation, and drug therapy
Smoking cessation	When readiness to change is confirmed, help the smoker set a quit date and select appropriate treatment strategies
Diabetes management	Develop a regimen of dietary adherence and weight control that includes exercise, oral hypoglycaemic agents/insulin therapy (where appropriate) and optimal control of other risk factors
Psychosocial management	Offer individual and/or small group education and counselling regarding adjustment to CHF, stress management, and health related lifestyle change
Other education/counselling	Provide information regarding medications (eg. indications, side effects), investigations and procedures, cardiac health beliefs and misconceptions and the importance of follow up by specialist, GP or other primary care provider
Physical activity counselling	Provide advice, support, and counselling about physical activity needs on initial evaluation and in follow up. Assistance with return to work. Consider simulated work testing for patients with heavy labour jobs
Exercise training	Develop a documented individualised exercise prescription for aerobic and resistance training based on evaluation findings, risk stratification, patient and program goals, and resources. Exercise prescription should specify frequency, intensity, duration, and modalities. Provide written guidelines for resumption of daily activities including a home walking program

Rehabilitation measurement tools

There is no consensus about which measures should be used to assess the CHF patient on admission to rehabilitation or to evaluate the outcomes and efficacy of rehabilitation, in either clinical or research settings. However, there are a cluster of self report and observational instruments which have gained favour in the CHF rehabilitation setting.

Exercise tests

The 6 minute walk test

This test assesses the submaximal level of functional capacity. It measures the distance that a patient can quickly walk on a flat, hard surface in a period of 6 minutes (the 6MWD), and requires a 100 ft hallway but no exercise equipment or advanced training for technicians. It globally evaluates the responses of all the systems involved during exercise, including the pulmonary and cardiovascular systems. A short 6MWD is a fairly accurate predictor of increased mortality and morbidity from heart disease.[21]

The 10 m shuttle-walk test

Two cones are placed 9 m apart and patients walk to and fro turning outside the cones. The test is progressive. The walking speed increases over stages lasting 1 minute and the test is terminated when a patient fails to maintain the required pace. The number of shuttles completed is recorded.[22] The SWT appears to be a safe and effective assessment of functional capacity in patients with CHF.

New South Wales Health Promotion Survey

The NSWHPS Physical Activity Questionnaire[23] was designed to measure self reported physical activity by assessing how many hours/minutes in the previous 2 weeks were spent participating in walking, vigorous activity, and light to moderate leisure activity (eg. gardening or bowls). Energy expenditure (kcal/week) is then estimated with 'adequate' (moderate to high) energy expenditure defined as greater than 800 kcal/week.

Quality of life instruments

The Kansas City Cardiomyopathy Questionnaire (KCCQ)[24] includes clinically relevant domains: physical limitations, symptoms (including

Table 5. Relative and absolute contraindications to exercise training among patients with stable CHF

Relative contraindications	Absolute contraindications
• ≥1·8 kg increase in body mass over previous 1–3 days	• Progressive worsening of exercise tolerance or dyspnoea at rest or on exertion over previous 3–5 days
• Concurrent dobutamine therapy	• Significant ischaemia at low work rates (<2 METS)
• Decrease in systolic blood pressure with exercise	• Uncontrolled diabetes
• NYHA functional class IV	• Acute systemic illness or fever
• Complex ventricular arrhythmia at rest or appearing with exertion	• Recent embolism
• Supine resting heart rate ≥100 bpm	• Thrombophlebitis
• Pre-existing comorbidities	• Active pericarditis or myocarditis
	• Moderate to severe aortic stenosis
	• Regurgitant valvular heart disease requiring surgery
	• Myocardial infarction within previous 3 weeks
	• New onset atrial fibrillation

frequency, severity, and change over time), self efficacy and knowledge, social function and quality of life. The quality of life item was adapted from the mental health inventory of the SF-36 because it is a marker of depression, an important prognostic variable in cardiovascular disease.

The Minnesota Living with Heart Failure Questionnaire (MLHF-Q)[25] is a disease specific, health related quality of life instrument composed of 21 items and three scales that measure the physical and emotional dimension and the overall score on health related quality of life. Eight separate items measure social and economical impairments that patients relate to their heart failure and are part of the overall score.

The Medical Outcome Study Short-Form 36 (SF-36)[26] was designed to provide an assessment of health status that was brief, psychometrically sound, and comprehensive. Domains include: physical functioning, bodily pain, general health, vitality, social functioning, and emotional and mental health. It is one of the most widely researched measures of health related quality of life and has been used in cardiac rehabilitation populations.

Patient knowledge instruments

The Dutch Heart Failure Knowledge Scale[27] is a 15 item, self administered questionnaire that covers items concerning patient knowledge. The instrument is a valid and reliable scale that can be used in research to evaluate the effect of education and counselling of CHF patients.

The Patient Knowledge Questionnaire for Heart Failure Patients[28] is a 10 item questionnaire, validated in patients from a heart failure clinic, and is reported to be a reliable and valid tool.

Table 6. Exercise training in cardiac rehabilitation: recommendations

Steady state training

- Frequency of sessions
  - 5–10 minutes sessions 2–3 times per week for more compromised patients; 20–30 minutes sessions 3 times per week (or more) for patients with good functional capacity
- Intensity of training sessions
  - initial phase: 40–50% peak VO2, increasing duration from 5–15 minutes
  - improvement phase: gradual increase to 60–80% peak VO2, increasing duration to 15–20 minutes (up to 30 minutes as secondary goal)
  - maintenance phase: usually after the first 6 months of training

Interval training

- Cycling
  - work phase of 30–120 seconds and recovery phase of 60–120 seconds at an intensity of 50% of maximum short term capacity (determined on exercise bike)
- Treadmill
  - work and recovery phases 60 seconds each

Self care instruments

The European Heart Failure Self Care Behaviour Scale[29] is a self administered yes/no questionnaire that covers items concerning self care behaviour of patients with CHF. Examples of the yes/no statements include: 'I weigh myself daily' and 'I contact my physician for shortness of breath'.

Conclusion

Cardiac rehabilitation that incorporates exercise training and education is safe for stable CHF patients provided that they have been properly selected and the training program is appropriately tailored to their individual needs and potential. As a result, most patients can expect to improve their exercise tolerance, functional ability, understanding of heart failure, and quality of life.

Conflict of interest: none.

References

1. Krum H, Jelinek MV, Stewart S, Sindone A, Atherton JJ, Hawkes AL, CHF Guidelines Core Writers. Guidelines for the prevention, detection and management of people with chronic heart failure in Australia 2006. Med J Aust 2006;185:549–57.
2. McMurray JJV, Stewart S. The burden of heart failure. Eur Heart J 2003;5:I3–113.
3. Australian Institute of Health and Welfare and the National Heart Foundation of Australia. Heart, stroke and vascular diseases – Australian facts 2004. Canberra: National Centre for Monitoring Cardiovascular Disease. 2004: p. 140.

4. The Task Force for the Diagnosis and Treatment of Chronic Heart Failure of the European Society of Cardiology. Guidelines for the diagnosis and treatment of chronic heart failure: full text (update 2005); doi:10.1093/eurheartj/ehi205.
5. Wheeldon NM, MacDonald TM, Flucker CJ, et al. Echocardiography in chronic heart failure in the community. Q J Med 1993;86:17–23.
6. Remes J, Miettinen H, Reunanen A, et al. Validity of clinical diagnosis of heart failure in primary health care. Eur Heart J 1991;12:315–21.
7. National Institute for Clinical Excellence. Management of chronic heart failure in primary and secondary care. Clinical guideline 5. London: NICE, 2003.
8. Clark AL. Exercise and heart failure: assessment and treatment. Heart 2006;92:699–703.
9. Working Group on Cardiac Rehabilitation and Exercise Physiology and Working Group on Heart Failure of the European Society of Cardiology. Recommendations for exercise training in chronic heart failure subjects. Eur Heart J 2001;22:125–35.
10. Mears S. The importance of exercise training in patients with chronic heart failure. Nurs Stand 2006;20:41–7.
11. Aronow WS. Epidemiology, pathophysiology, prognosis, and treatment of systolic and diastolic heart failure. Cardiol Rev 2006;14:108–24.
12. Ko JK, McKelvie RS. The role of exercise training for patients with heart failure. Eur Med Phys 2005;41:35–47.
13. Konstam M, Dracup K, Baker D. Heart failure: evaluation and care of subjects with left ventricular systolic dysfunction. Clinical practice guidelines No.11: AHCPR. Agency for Health Care Policy and Research and the National Heart, Lung, and Blood Institute. Public Health Service: US. Department of Health and Human Services, 1994.
14. Rees K, Taylor RS, Singh S, Coats AJ, Ebrahim S. Exercise based rehabilitation for heart failure. Cochrane Database Syst Rev 2004;(3):CD003331.
15. Goble AJ, Worcester MUC. Best practice guidelines for cardiac rehabilitation and secondary prevention. Heart Research Centre. Melbourne: Department of Human Services Victoria, 1999.
16. Butland RJA, Pang J, Gross ER, Woodcock AA, Geddes DM. Two–, six–, and 12–minute walking tests in respiratory disease. BMJ 1982;284:1607–8.
17. Borg GAV. Psychophysical bases of perceived exertion. Med Sci Sports Exerc 1982;14:377–81.
18. Volaklis KA, Tokmakidis SP. Resistance exercise training in patients with heart failure. Sports Med 2005;35:1085–103.
19. 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;116:693–706.
20. Ko JK, McKelvie RS. The role of exercise training for patients with heart failure. Eur Med Phys 2005;41:35–47.
21. Passantino A, Lagioia R, Mastropasqua F, Scrutinio D. Short term change in distance walked in 6 min is an indicator of outcome in patients with chronic heart failure in clinical practice. J Am Coll Cardiol 2006;48:99–105.
22. Keell S, Chambers J, Francis D, Edwards D, Stables R. Shuttle–walk test to assess chronic heart failure. Lancet 1998;352:705.
23. Bauman A, Bellew B, Booth M, Hahn A, Stoker L, Thomas M. Towards best practice for the promotion of physical activity in the areas of NSW. NSW Health Department: Centre for Disease Prevention and Health, 1996.
24. Green CP, Porter CB, Bresnahan DR, Spertus JA. Development and evaluation of the Kansas City Cardiomyopathy Questionnaire: a new health status measure for heart failure. J Am Coll Cardiol 2000;35:1245–55.
25. Middel B; Bouma J, de Jongste M, et al. Psychometric properties of the Minnesota Living with Heart Failure Questionnaire (MLHF–Q). Clin Rehabil 2001;15:489–500.
26. Ware JE. SF–36 Health survey: manual and interpretation guide. Boston: The Health Institute, New England Medical Centre, 1993.
27. van der Wal MH, Jaarsma T, Moser DK, van Veldhuisen DJ. Development and testing of the Dutch Heart Failure Knowledge scale. Eur J Cardiovasc Nurs 2005;4:273–7.
28. Lainscak M, Keber I. Validation of self assessment patient knowledge questionnaire for heart failure patients. Eur J Cardiovasc Nurs 2005;4:269–72.
29. Jaarsma T, Stromberg A, Martensson J, et al. Development and testing of the European Heart Failure Self–Care Behaviour scale. Eur J Heart Fail 2003;5:363–70.

afp **CORRESPONDENCE** email: afp@racgp.org.au