

Position statement

Exercise & Sports Science Australia Position Statement on exercise training and chronic heart failure

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Abstract

Chronic heart failure (CHF) is a complex syndrome characterised by progressive decline in left ventricular function, low exercise tolerance and raised mortality and morbidity. Regular exercise participation has been shown to be a safe and effective treatment modality in the majority of CHF patients, partially reversing some of the maladaptations evident in myocardial and skeletal muscle function, and resulting in improvements in physical fitness and quality of life, and perhaps reduced mortality. The volume and intensity of exercise that is recommended depends on the syndrome severity, however in most patients it should consist of a combination of low-to-moderate intensity aerobic (endurance) exercise on most days of the week and individually prescribed low-to-moderate intensity resistance (strength) training at least twice per week. Additionally, all patients should be closely monitored prior to and during exercise for contraindications by an appropriately trained health professional. The purpose of this statement is to inform and guide exercise practitioners and health professionals in the safe and effective prescription and supervision of exercise for patients with CHF.

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1. Background

This Position Statement provides evidence-based guidelines for exercise interventions in individuals with stable chronic heart failure (CHF).

CHF is a complex clinical syndrome in which the ability of the left ventricle to fill with or eject blood¹ is impaired. The diagnosis requires a combination of specific clinical

features linked with an objective demonstration of abnormal left ventricular function. The overall prevalence of heart failure in general Australian population is approximately 2.5% in people aged 55–64 to 8.2% in those aged 75 years and over.² It is one of the most common reasons for hospital admission and it is estimated that in Australia CHF accounts for a total of 100,000 hospitalisations per annum with 1.4 million days of hospital stay at a cost of >\$1 billion annually.³ CHF is also extremely common in general (or family medicine) practice in Australia with a prevalence of 13.2% in consecutive consultations with patients over the age of 60 years.⁴

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Table 1
NYHA classification.

Class I	No symptoms at rest, symptoms only at levels of exertion that would limit healthy individual
Class II	No symptoms at rest or mild exertion, symptoms on moderate exertion
Class III	No symptoms at rest, symptoms at mild exertion
Class IV	Symptoms at rest

The prognosis for patients with CHF remains poor in spite of improved medical treatments.⁵ The two main causes of heart failure are hypertension and coronary artery disease, where long-term exposure to raised pressure, or acute insult to the cardiac muscle, result in ventricular remodelling and dysfunction.⁶ The hallmark symptoms of CHF are fatigue⁷ and dyspnea,⁸ accompanied by decreased exercise tolerance,⁹ and strength.^{9,10} The severity of CHF symptoms are commonly classified under the New York Heart Association (NYHA) classification system (Table 1).¹

Although reduced cardiac output defines the syndrome of CHF, it is widely accepted that functional capacity and cardiac function are poorly correlated and that peripheral factors including impaired blood flow¹¹ and skeletal muscle dysfunction contribute to the exercise intolerance evident in this group. Functional capacity, ideally measured as peak cardiopulmonary oxygen uptake ($\dot{V}O_2$ peak), is more important than ejection fraction and pulmonary artery wedge pressure as a prognostic indicator in advanced HF, and $\dot{V}O_2$ peak predicts survival better than changes in these haemodynamic indices.^{12,13}

2. Role of exercise for management of CHF

Physical inactivity is a risk factor for heart disease.¹⁴ The importance of adding exercise to the medical management of patients with CHF has been demonstrated in many studies. There is an inverse relationship between physical fitness and mortality.^{15,16} Even moderate improvements in physical fitness can improve health status,¹⁶ functional capacity and quality of life and decrease hospitalisation and mortality.^{17,18} The recently completed HF-ACTION trial,¹⁹ the largest exercise study in CHF to date, randomised 2331 heart failure subjects (NYHA II–IV, EF < 35%) to either usual care plus 12 weeks of supervised and ongoing home based aerobic training or usual care alone and reported no change in all-cause mortality and CHF hospitalisations at a median follow up of 30 months. However, after adjustment for predetermined prognostic factors, exercise training was associated with a statistically significant 15% decrease in all-cause mortality and CHF hospitalisations. It is important to acknowledge that this study yielded only modest overall gains in $\dot{V}O_2$ peak, and small increases in 6-min walk test (6MWT) distance. Although in the opinion of the authors of this statement the exercise intervention was sound as it was comparable to other smaller studies that have reported improvements in exercise

tolerance,^{20–22} it is possible that adherence levels were lower than intended and this may account for the lack of effect on the primary endpoints. However, there are many smaller randomised clinical trials showing clinically and functionally significant improvements in $\dot{V}O_2$ peak,^{20–22} which has been closely linked to cardiovascular mortality in heart failure patients.^{23,24} Alternatively, VE/ $\dot{V}CO_2$ slope has also been used as a prognostic marker. It has been recommended that all data for an incremental exercise test from the initiation of exercise to maximal exertion be included to calculate the VE/ $\dot{V}CO_2$ slope.²⁵ Arena et al.²⁵ reported that 24 of 26 studies found that the VE/ $\dot{V}CO_2$ relationship was superior to $\dot{V}O_2$ peak as a prognostic marker. It seems that $\dot{V}O_2$ peak and VE/ $\dot{V}CO_2$ slope provide independent and complementary information for the study of interventions in HF, with the latter perhaps better reflecting the overall, multi-system pathophysiology associated with HF.

Low aerobic power ($\dot{V}O_2$ peak) and exercise intolerance are common in CHF patients^{26,27} with substantial evidence linking low $\dot{V}O_2$ peak with poor prognosis.^{23,24} Aerobic training improves exercise capacity and $\dot{V}O_2$ peak in patients with CHF.^{14,28,29} It is estimated that over 50% of patients with heart failure have preserved systolic function.³⁰ Published exercise training data suggest that patients with preserved systolic function will improve $\dot{V}O_2$ peak at least as much as HF patients with reduced systolic function.³¹ Following exercise training HF patients may expect an improvement in $\dot{V}O_2$ peak in the order of 15%,¹⁸ however not all patients respond to this extent. Possible reasons for low exercise training responses are low resting cardiac output,³² poor adherence and autonomic neuropathy.³³ As many patients are sedentary and debilitated, average gains in aerobic power of 20% are achievable in as little as 3–4 weeks^{34,35} and have important implications for physical function and quality of life. Concerns regarding the potential for adverse myocardial remodelling in response to exercise training have been allayed by evidence that aerobic training results in small but significant improvements (falls) in end-diastolic volume (EDV) and end-systolic volume (ESV),²¹ while other work has demonstrated benefits in diastolic function,³⁶ indicating modest exercise-induced improvements in cardiac function. Exercise training in patients with CHF is generally safe, with no deaths and only 1 adverse event in 60,000 patient hours of supervised training documented in published trials, predominantly in subjects with NYHA Class \leq III symptoms.¹⁸ Interval training has been trialled as a means for heart failure patients to be able to exercise at relatively high intensities.^{20,37} This may offer an effective alternative to moderate intensity continuous training. $\dot{V}O_2$ peak improved by 46% following high intensity interval training, compared to 14% for moderate intensity continuous training,²⁰ with no reported adverse events and even small improvements in left ventricular end-diastolic volumes and stroke volume.

CHF is associated with maladaptations in skeletal muscle structure and function. Resistance training is considered the most effective exercise modality to improve muscle mass,

Table 2

Exercise recommendations for patients with CHF. The recommendations are based on the recommendations of the American College of Sports Medicine,⁴⁷ as well as Volaklis and Tokmakidis⁴¹ and Braith and Beck.⁴⁰ The recommendations are also consistent with the authors' collective and individual experiences, having designed and supervised for heart failure patients, exercise programs amounting to many thousands of patient hours in four regions across Australia.

Type of exercise	Class	Frequency	Intensity/volume	Duration
Aerobic training (activities such as walking/running, cycling and swimming)	NYHA I–II	4–7 days/week	Exercise intensity should be below myocardial ischaemic threshold, if applicable RPE 11–14 (Borg 6–20 point scale), or 40% to 75% of HR _{peak} where HR _{peak} is predetermined in a symptom-limited graded exercise test, or 40–70% of $\dot{V}O_2$ peak Higher intensities of exercise (up to 80% of $\dot{V}O_2$ peak) may be applied in hospitals or exercise centres that have the equipment and personnel to manage severe adverse events using advanced cardiac life support Progression in exercise intensity is managed by falls in RPE or HR at the same exercise intensity, with the new intensity remaining within the RPE and HR bands	Commence at 10–15 min at target exercise intensity, progressing gradually according to patient's progress and tolerance to 45–60 min Interval training is well tolerated by CHF patients: initial 1:1 exercise/rest ratio, progressing to 2:1 exercise/rest ratio
	NYHA III–IV	4–7 days/week	RPE ≤ 13, or 40–65% of HR _{peak} where HR _{peak} is predetermined in a symptom-limited graded exercise test, or 40–60% of $\dot{V}O_2$ peak	See above
	NYHA I–II	2–3 days/week	RPE 11–15	Commence at 20 min at target exercise intensities, progressing gradually according to patient's progress and tolerance to 45–60 min
Resistance (weight) training. Circuit weight training. Theraband exercise. Body weight exercise	NYHA III–IV	2 days/week	6–15 repetition per set Commence at 1 set per exercise, progressing to up to 3 sets 4–8 different exercises for the major muscle groups RPE 10–13 4–10 repetition per set Commence at 1 set per exercise, progressing to up to 2 sets 3–4 different exercises for the major muscle groups	See above
	NYHA I–IV	2–3 days/week	Stretch the major muscle groups affecting the hips, knees, upper and lower spine, chest and shoulders	5–10 min

HRR = heart rate reserve; RPE = Borg rating of perceived exertion 6–20 point scale.

strength and power in healthy participants, with strength and even power needed to perform activities of daily living. Further, knee flexor muscle strength is a strong predictor of mortality outcomes in CHF.³⁸ Evidence is accumulating that carefully prescribed and administered low-to-moderate intensity resistance exercise is safe for patients with CHF, with little evidence of adverse changes to LV structure and function or to central haemodynamics.³⁹ Further, resistance training for CHF patients leads to improvements in exercise tolerance, cardiac and skeletal muscle function, sympathovagal balance and quality of life.^{22,40–43}

While crossover in fitness benefits have been identified with each mode of exercise,⁴⁴ combined resistance and aerobic training is likely to optimise the benefits of both components of fitness by inducing central and peripheral benefits. A circuit training approach to combined aerobic and resistance training minimises haemodynamic burden by focusing on small muscle groups and maximising peripheral adaptations. This approach is considered safe³⁹ and has proven successful in CHF in terms of improving aerobic capacity, skeletal muscle and vascular function.^{45,46}

3. Exercise prescription – recommendations

Only patients with stable CHF, determined by a medical practitioner, should undertake an exercise program, especially for those with NYHA Class IV in whom exercise training is a relative contraindication. Patients with CHF often have multiple co-morbidities and take numerous medications. As such, exercise prescription should be developed on evidence-based guidelines and tailored to meet the individual's functional and symptomatic status that should be established using symptom-limited exercise capacity and functional testing before embarking on an exercise program. Furthermore, although benefits of exercise training do not appear to depend on the aetiology of CHF, it does warrant consideration, especially in patients with CHF due to ischaemic heart disease, severe hypertension or valvular disease. In general, any type of moderate intensity physical activity (aerobic, resistance, combined aerobic and resistance, or circuit weight training) may have beneficial effects on clinical outcomes, functional capacity and quality of life.^{41,44} The recommendations for exercise training for individuals with CHF outlined in Table 2 are based partly on the recommendations of the American College of Sports Medicine,⁴⁷ as well as those of Volaklis and Tokmakidis⁴¹ and Braith and Beck.⁴⁰ The recommendations are also consistent with the authors' collective and individual experiences, having designed and supervised for heart failure patients, exercise programs amounting to many thousands of patient hours in four regions across Australia. It is recommended that warm-up and cool-down (including stretching) are incorporated in each training session. The latter is important for reducing the risk of post-exercise hypotension.

4. Special considerations and contraindications to exercise

Table 3 includes absolute and relative contraindications for exercise in patients with CHF.

Patients with CHF are generally prescribed a range of medications to reduce myocardial load and disease progression. In general, angiotensin converting enzyme inhibitors, angiotensin receptor blockers, digoxin, diuretics and nitrates tend to improve tolerance to exercise in CHF patients, while calcium channel blockers, statins, anti-arrhythmics and anti-thrombotics have little effect.⁴⁷ Chronic beta-adrenergic blockade has had an extraordinarily beneficial impact on both mortality and functional capacity in CHF patients. While beta blockers are mandatory in the management of CHF, they blunt heart rate responses to exercise, and heart rates should therefore not be used as the primary determinant of exercise intensity in these patients.⁴⁸ Exercise tolerance for CHF patients may be affected by up- or down-titration of some medications and exercise prescription may need to be modified when medications are changed. Generally it is more practical to prescribe exercise intensities on the basis of ratings of perceived exertion or actual work rates determined during prior exercise testing, rather than percentages of maximal heart rate, even if the latter has been established during the exercise testing.

Heart failure patients exhibit impaired thermoregulatory responses to heat exposure.⁴⁹ Common medications such

Table 3

Absolute and relative contraindications for exercise training in patients with CHF.

Absolute contraindications

1. Progressive worsening of exercise tolerance or dyspnoea at rest or on exertion over previous 3–5 days
2. Significant ischaemia at low exercise intensities (<2 METS, or ~50 W)
3. Uncontrolled diabetes
4. Acute systemic illness or fever
5. Recent embolism
6. Thrombophlebitis
7. Active pericarditis or myocarditis
8. Severe aortic stenosis
9. Regurgitant valvular heart disease requiring surgery
10. Myocardial infarction within previous 3 weeks
11. New onset atrial fibrillation
12. Resting heart rate >120 bpm

Relative contraindications

1. ≥ 2 kg increase in body mass over previous 1–3 days
2. Concurrent continuous or intermittent dobutamine therapy
3. Decrease in systolic blood pressure with exercise
4. New York Heart Association Functional Class IV
5. Complex ventricular arrhythmia at rest or appearing with exertion
6. Supine resting heart rate ≥ 100 bpm
7. Pre-existing co-morbidities
8. Moderate aortic stenosis
9. BP > 180/110 mmHg (evaluated on a case by case basis)

Adapted from: Recommendations for exercise training in chronic heart failure patients. Working Group on Cardiac Rehabilitation & Exercise Physiology and Working Group on Heart Failure of the European Society of Cardiology. Eur Heart J 2001;22:125–35.

as beta blockers, anti-adrenergic agents and diuretics may impair the ability to regulate body temperature during exercise. As a consequence, patients and supervisors should be aware of the signs of heat illness and reduce the exercise dose during periods of high heat and/or humidity. Patients should also be encouraged to ensure appropriate hydration and clothing to aid cooling by evaporation, and exercising indoors is advised when the outside ambient temperature may cause high thermoregulatory demands on the patient.

It is highly recommended that the patient undergoes a symptom-limited graded exercise test prior to commencement of exercise training. General recommendations for the symptom-limited graded exercise test for HF patients include the use of bicycle ergometer or treadmill, with small workload increments (based on evaluation of the patient's history). A range of possible test protocols have been described previously⁵⁰ however the authors believe that the Bruce 30 second ramp protocol⁵⁰ is ideal if using a treadmill, while a good test when using a bicycle ergometer is a 10 W/min incremental protocol. The starting point for the cycle protocol is usually 20 W if equipment permits or unless the patient's condition indicates a higher starting point. The patient should have close clinical and electrocardiographic monitoring in a setting where resuscitation, including defibrillation, is available. This testing, along with the clinical assessment and measurement of left ventricular function, is used to determine whether a patient is safe to commence an unmonitored exercise program. If the patient has been clinically stable, a previous exercise test within the past 6 months is satisfactory for safety purposes. Exercise testing is also helpful in excluding current myocardial ischaemia, determining ischaemic thresholds for those in whom complete control of ischaemia is not possible, excluding exercise-induced ventricular tachycardia, determining ventricular rate control in patients with atrial fibrillation, assessing functional capacity, and measuring both work rates and heart rates at sub-maximal and maximal levels of exercise. Pre-program functional tests (e.g. 6MWT, sit-to-stand) and tests for musculoskeletal strength and endurance are also useful for planning and evaluating an exercise intervention.

Depending on the overall clinical status of the individual, aerobic,³⁵ and low level resistance training may be undertaken as little as 3 weeks⁵¹ after acute myocardial infarction (AMI). In those who have undergone early symptom-limited exercise tests, training has been demonstrated to be safe in patients only 2 weeks after larger Q-wave infarctions, although it should be delayed to 5 weeks if the AMI was complicated by pulmonary oedema.⁵² Although a dose-response relationship may exist between intensity of training and change in functional capacity, it needs to be recognised that as exercise intensity increases, so does the haemodynamic burden and the potential risk for adverse events. Most CHF exercise training studies to date have been conducted in hospitals or exercise centres that have the equipment and the personnel for close monitoring and the capacity to manage acute adverse events (such as cardiac arrest and acute

ischaemia). We therefore recommend limiting exercise intensity to moderate (see Table 2) outside of these hospital environments.

It is important that the following assessments are performed prior to exercise sessions, and before the patient leaves the exercise centre (see also Table 3): (a) blood pressure: to screen for hypo- or hypertension. If resting systolic blood pressure is greater than 180 mmHg or resting diastolic blood pressure >110 mmHg, the exercise session should not commence. More commonly, CHF patients have low blood pressure, often linked to orthostatic hypotension and can exhibit post-exercise falls in blood pressure due to increasing return of vagal activity. These are often accompanied by symptoms such as dizziness, and blood pressure should be closely monitored. (b) Heart rate: if tachycardia (>100 bpm) is evident at rest, the exercise session should not commence. (c) Body mass: an increase of more than 1–2 kg in the previous few days may indicate fluid retention that can lead to acute pulmonary oedema. In addition to these, it is recommended that clinical exercise physiologists ask clients if they have experienced new occurrences of chest pain (angina), worsening orthopnea or exercise-induced dyspnoea, or any change in their physical (illness or fever) or mental (depression, anxiety) wellbeing since their previous exercise session.⁴⁷ Where possible, ECG should be used, particularly in the early sessions, to monitor for tachy- and brady-arrhythmias and myocardial ischaemia.⁴⁷ Pulse oximetry is useful in early sessions to monitor for haemoglobin oxygen desaturation during exercise. Where possible, blood pressure should be monitored periodically during or very shortly after aerobic and strength exercises, and for at least 10 min during recovery before clients leave the exercise facility.

The health professional should be capable of monitoring, managing and reporting signs and symptoms of worsening heart failure, excessive shortness of breath or fatigue, and vasovagal signs and symptoms including bradycardia, excessive sweating, dizziness, confusion and acute hypotension that may lead to syncope or rarely sudden death. If during exercise, systolic blood pressure falls more than 10 mmHg in response to an increase in workload, exercise should be stopped.⁴⁷ All adverse events related to exercise or new or unexpected occurrence of signs or symptoms indicating worsening condition must be reported promptly to the primary care medical practitioner or emergency medical personnel.

Exercise for patients with implantable devices (pacemaker, defibrillator) is considered safe, however, special consideration may be required in order to avoid pacing complications. It is recommended that exercise heart rates reach no higher than 10–15 beats below the implantable cardioverter-defibrillator (ICD) tachycardia threshold.⁵³ Furthermore, upper body resistance exercise should be restricted until 6 weeks after implantation to prevent dislodgement of newly implanted device leads and healing of the defibrillator site.

5. Summary

Chronic heart failure is a progressive life-threatening syndrome characterised by declines in left ventricular function. While exercise training is not a cure for heart failure, appropriately prescribed exercise results in improvements in exercise tolerance due to improvements in musculoskeletal, respiratory, and autonomic function, with some evidence suggesting anti-remodelling benefits for the myocardium. All of these help to improve both clinical and functional outlook and may reduce mortality and hospitalisations. Exercise should be seen as a vital strategy to reduce the progression of, or even partly reverse, the maladaptations that occur in this syndrome. Individually prescribed and carefully supervised exercise testing and prescription, undertaken by appropriately trained health professionals, can safely and effectively reduce the burden of disease and improve prognosis and quality of life in medically stable CHF patients.

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