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ABSTRACT

Peripheral artery disease (PAD) is caused by atherosclerotic narrowing of the arteries supplying the lower limbs often resulting in intermittent claudication, evident as pain or cramping whilst walking.

Supervised exercise training elicits clinically meaningful benefits in walking ability and quality of life. Walking is the modality of exercise with the strongest evidence and is recommended in several national and international guidelines. Alternate forms of exercise such as upper or lower-body cycling may be used, if required by certain patients, although there is less evidence for these types of programmes. The evidence for progressive resistance training is growing and patients can also engage in strength-based training alongside a walking programme. For those unable to attend a supervised class (strongest evidence), home-based or "self-facilitated" exercise programmes are known to improve walking distance when compared to simple advice.

All exercise programmes, independent of the mode of delivery, should be progressive and individually prescribed where possible, considering disease severity, comorbidities and initial exercise capacity. All patients should aim to accumulate at least 30 minutes of aerobic activity, at least three times a week, for at least 3 months, ideally in the form of walking exercise to near maximal claudication pain.

Key Words: Peripheral Arterial Disease, Exercise, Intermittent Claudication

SUMMARY BOX

WHAT IS ALREADY KNOWN:

- Supervised exercise training promotes clinically meaningful benefit in patients with intermittent claudication.
- Walking as an exercise modality currently has the strongest level of evidence

WHAT THIS STUDY ADDS:

- A concise summary of evidence and practical recommendations for exercise implementation for practioners, including example protocols for exercise training.
- Progressive resistance training may be used as a supplement to walking

INTRODUCTION

Lower-limb peripheral artery disease (PAD) is an atherosclerotic cardiovascular disease in which the arteries that carry blood to the legs and feet become hardened, narrowed and/or obstructed by the build-up of atheroma.[1] PAD is a common problem thought to affect over 200 million people worldwide.[2] The total disease prevalence is approximately 13% of adults >50 years old, with major risk factors including smoking, diabetes and dyslipidaemia.[3]

The most classic symptom of PAD is intermittent claudication (IC). This is ischaemic muscle pain that usually presents in the calves (but can include the thighs or buttocks), is precipitated by exertion and relieved with rest (Figure 1).[4] This pain is thought to be due to a mismatch between the oxygen demand (of the working muscle) and an inadequate blood supply (due to the narrowed arterial pathway).[5]

Although PAD is progressive (in the pathological sense), the clinical course is relatively stable.[6] However, patients with PAD have higher a burden of cardiovascular disease and are at greater risk of major cardiovascular events.[7] Another major issue for many patients is the severe decline in functional capacity ($\dot{V}O_{2Peak}$) which are comparable to patients with heart failure and reduced ejection fraction.[8] The reduction in functional capacity is commonly caused by a decline is in walking capacity; which may be up to less than 50% of healthy aged-matched controls.[9] Factors influencing the walking distance or speed at which symptoms occur are multifactorial and include the site and severity of disease, walking pace, terrain, incline and footwear.[10] These physical constraints in turn have negative connotations on patient's mental health and there are strong associations with depression, poor quality of life (QoL) and further avoidance of physical activity.[11,12] This cycle of activity avoidance only leads to worsening functional ability and there is some evidence to suggest it also leads to an elevated mortality risk independent of disease severity and age.[13]

Treatment for patients with IC involves secondary prevention of cardiovascular disease risk, including smoking cessation, diet changes, lipid modification and statin therapy, antiplatelet therapy, and management of diabetes and hypertension. In addition to therapeutic intervention and lifestyle modification, the primary treatment to address the functional impairment outlined above is for patients to engage in appropriate exercise training, best achieved through a supervised exercise programme.[14] This is supported by multiple consensus guidelines from various governing bodies.[15] [16] [17] .[18] However, they lack detail and consistency (between guidelines) as to the appropriate principles of exercise such as intensity and progression (table one), which impacts upon effective implementation. In addition to inconsistencies in the recommendations for exercise, there is also variability in the delivery of exercise programmes globally with some clinicians reporting lack of expertise or support to guide the exercise delivery [19-21].

This guideline for practitioners therefore aims to accompany these consensus guidelines to provide a succinct but more detailed overview of, and recommendations for, exercise prescription and training for IC. Whilst we appreciate that delivery and provision will vary, the key exercise prescription components will remain and as such, this document will be relevant for exercise practioners worldwide. In addition, we provide advice for the implementation of the exercise prescription guidelines into clinical practice (table two), which also includes information on structured alternatives when SEPs are not available [19,22]

Walking ability

Measures of walking ability include pain-free and maximum-walking distance (or time) obtained during standardised treadmill testing and /or the distance covered in the 6-minute 30-meter corridor walk test. Several treadmill protocols have been reported, but the ‘Gardner/Skinner’ incremental protocol is most commonly used.[23,24] This involves a constant speed of 3.2 km/h at a 0% grade, increasing by 2% every 2 minutes. The advantage of using a treadmill test is that it can be standardized (i.e speed of treadmill, grade of treadmill), although it is may not be as reflective of normal everyday walking (6-minute walking distance)[25,26].

Quality of life

Several generic and condition-specific questionnaires have been used to assess QoL. The most validated, responsive and reliable questionnaires in the IC population are the Short-Form-36 (SF-36) and King's College Hospital's VascuQol questionnaires, respectively.[27,28] Additional and commonly used questionnaires include the Walking Impairment Questionnaire[29] and the Peripheral Artery Questionnaire[30].

EXERCISE TRAINING

Benefits of exercise training

A recent Cochrane review concluded that there is high-quality evidence showing that supervised exercise programmes (a variety of regimes) elicit important improvements in both pain-free and maximum-walking distance compared with no-exercise control in people with IC[14]. A meta-analysis of 9 trials (n=391) showed a mean between-group difference in pain-free walking distance at follow-up of 82 m (95% CI 72–92 m; (follow-up ranging 6 weeks to 2 years) and maximum walking distance of 120 m (95% CI 50.79-190 m). The most commonly tested mode of exercise was walking, with one cycling intervention. The corresponding difference for maximum walking distance was 120 m (95% CI 51–190 m; 10 trials, n=500). Improvements of this magnitude are likely to represent clinically meaningful changes in ambulatory function.[31]

The same review also reported that there was moderate-quality evidence for improvements in physical and mental aspects of QoL, assessed using the SF-36.[14] A meta-analysis of data at 6 months follow-up showed the physical component summary score to be 2 points higher in exercise versus control (95% CI 1 to 3; 5 trials, n=429). The corresponding difference for the mental component summary score was 4 points (95% CI 3 to 5; 4 trials, n=343). Such differences have the potential to be clinically meaningful.[14]

Modes of exercise

In most studies, supervised exercise programmes have involved treadmill or track walking at an intensity that elicits moderate to maximal claudication pain.[32] There is a strong evidence-base for this type of training, and clinical guidelines cite it as the preferred modality (e.g., TASC II).[15] As of 2011, alternate exercise modalities had not been extensively studied[33]. In 2005, a randomised trial of 104 participants provided evidence that a 24-week intervention of either cycling or arm-cranking are viable alternatives for improving maximum walking distance (shuttle-walk) up to 29% and 31% respectively.[34] These modalities may be most useful for patients who are unwilling/unable to walk because of severe pain or deconditioning.[35] Resistance training may also have a complementary role (e.g., for improving muscular strength)[36]; however, at this point, international guidelines suggest it should not be used as a substitute for aerobic exercise because its impact on walking distance appears modest (e.g., McDermott et al 2009). Nevertheless, there is emerging evidence to support its efficacy, and it should no longer be a mode of exercise that is ignored. A recent systematic review and meta-analysis (n=826; 363 resistance trained) demonstrated that resistance training (in comparison to control) can significantly improve both maximum walking distance via constant treadmill testing (SMD 0.51 [95% CI 0.23-0.79]) and maximum walking distance via progressive treadmill testing (SMD 0.45 [95% CI 0.08-0.83]. Only six-minute claudication onset time (not pain-free treadmill distance) was significantly improved with resistance training (MD 82m [95% CI 40.91-123.54).[36]

Frequency of exercise

A comparison of different training frequencies for patients with IC has not been investigated in a single study. The 1995 meta-analysis of Gardner and Poehlman suggested that an exercise frequency of ≥3 sessions per week was associated with better outcomes compared with <3 times per week, although it should be noted that it pooled data from randomised controlled trials and uncontrolled studies.[37] In addition, the 2004 review of Bulmer and Coombes also identified 3 sessions per week as the optimal frequency for maximum improvements in walking distance.[38] Conversely, a meta-analysis in 2012 including 1054 patients did not identify an optimal frequency for programmes[39]. The authors of the 2012 meta-analysis do note however, that a SEP with three sessions per week (in combination with duration of programme and session) "would give the best results".[39] Therefore, frequency of supervised exercise programmes should aim be at least three times per week, which is in line with common physical activity guidelines for the general population.[17]

Duration of programme

No standardised duration of programme for patients with IC has been identified, with exercise programme length ranging from as little as 2 weeks to as many as 18 months.[32] Gardner et al (2012) measured outcomes at 2, 4 and 6 months (n = 80) and demonstrated that exercise-mediated improvements in pain-free and maximum walking distances were largely achieved in the first 2 months.[40] Additional meta-analysis have also demonstrated that improvements in treadmill walking occur following 3 months of supervised exercise[38,41,42]. It may be likely that the optimal prescription is difficult to elucidate due to heterogeneity of studies, including differences in frequency, intensity and type of the exercise. Currently we recommend that programmes should be at least a minimum of 12 weeks in duration.

Intensity of exercise

Exercise intensity is commonly prescribed on the basis of heart rate, rating of perceived exertion, or $\dot{V}O_{2peak}$ obtained via exercise stress testing,[43] and may be classified as low, moderate or vigorous based on American College of Sports Medicine guidelines.[44] There is limited information on the appropriate intensities of exercise programmes for patients with PAD.[17,45] However, a meta-analysis by Parmenter et al (2015) investigated the relationship between exercise intensity, $\dot{V}O_{2peak}$ (i.e. aerobic capacity), and maximal walking distance and demonstrated that the greatest improvements occurred when exercise intensity was between 70-90% HRmax (i.e. vigorous according to the American College of Sports Medicine guidelines.[46] A further systematic review by Pymer et al (2019) focusing on high-intensity exercise identified four studies that prescribed exercise on the $\dot{V}O_{2peak}$ or HRmax achieved during baseline testing. Overall (six studies) demonstrated significant improvements in treadmill maximum walking distances compared to a control group (generally consisting of exercise advice alone).[47] However, further research is required to establish the relationship between intensity (moderate versus vigorous) and walking improvements and compare those findings to supervised exercise programmes.

Claudication pain scale

Relatively few trials have used classically defined measures of exercise intensity as described above and for patients with PAD there is a common misconception between exercise “intensity” and severity of leg pain or discomfort.[48] Most reported trials in the literature utilise the claudication pain scale to instruct patients when to stop exercising and not exercise intensity markers such as heart rate. The claudication pain scale is a continuous scale from 1, indicating no pain, to 5 indicating severe pain,[46] with trials often instructing patients to walk to near-maximal pain levels.

Three studies have specifically investigated the relationship between "intensity" (based on pain) and walking outcomes.[49-51] Mika *et al* (2013) utilised different intensities corresponding to scores on the pain scale and matched exercise duration in 60 patients.[50] Gardner et al (2005) prescribed intensity as "high – 80%" or "low – 40%" based on the maximal grade achieved at baseline in 31 patients.[52] Finally, Novakovic et al (2019) randomised 36 patients to either moderate or pain-free walking, with moderate training prescribed on 70% of the patients predicted HR max.[51] For all studies, outcomes including pain-free and maximum walking distance did not differ between the intensities prescribed. This may highlight that the volume of exercise (and not intensity prescribed) is perhaps the most important factor for improving walking distance in patients with IC.[33,46,53] With regard to pain, overall the current evidence seems to favour patients walking near maximal pain for beneficial outcomes. However, walking to no pain, or minimal pain, may also been shown to be effective for this cohort.[51,53] Indeed, a meta-analysis by Parmenter et al (2011) showed that walking without inducing claudication pain produced significant improvements in initial claudication distance and also improved absolute claudication distance.[33] Additionally, a meta-analysis (six studies) in 2015 demonstrated that improvements in cardiorespiratory fitness were obtained when walking to mild pain (MD 0.79 $ml/kg/min^{-1}$ [95% CI 0.45-1.14]).[46] Current recommendations are if patients can tolerate, then walking to moderate pain (i.e 4-5 on the claudication scale) may be suitable. If patients are unable to tolerate higher levels of pain on the claudication scale, then they can walk to low levels of pain, provided the volume of exercise is sufficient,[44] which may improve adherence levels.

Supervision

Despite consistent evidence demonstrating the clinical effectiveness of supervised exercise programmes, a European survey conducted in 2012 demonstrated that approximately 30 % of respondents had access to a supervised programme,[54] with similar availability in the UK.[19]

Similar evidence has recently emerged from America with 54 % of respondents stating no exercise to a supervised exercise programme.[20] These low provision rate may be attributed to several factors including funding provision, facilities, referral pathways, resources and a lack of trained staff.[19,55]

A 2014 review noted uncertainty regarding the benefits of supervised exercise programmes over unsupervised exercise, especially regarding QoL.[48] Despite the apparent superiority of supervised exercise programmes, there is still a need to develop alternative programmes, given that supervised programmes may be "unpopular" with patients due to financial, time or transport limitations,[56,57] or simply because they are looking for a "quick fix".[58] As supervised programmes may be unavailable to a large proportion of patients, the development of alternative home-based or "self-facilitated" programmes have been increasingly trialled. These types of interventions have varied in content but include; psychological interventions,[59] such as cognitive behavioural changes,[60] step-monitoring,[61] and patient education.[62]

Home exercise programmes

Evidence for home-based or self-managed programmes is currently conflicting. In 2013, a systematic review reported that there was low-level evidence to suggest home-based programmes can improve walking distance and QoL in comparison to walking advice or non-exercise.[63] In 2018, a Cochrane review including 21 studies and 1400 patients, reported that there was high-quality evidence showing greater improvements in maximum walking distance (measured via treadmill testing) at three months amongst patients enrolled in a supervised exercise programme versus a home-based programme (95% CI 0.12 – 0.65), or in patients who received walking advice only (95% CI 0.53 – 1.07).[64] This translates to walking distance improvements of between 120-210 m in favour of supervised exercise, respectively, with similar improvements maintained at 6 and 12 months. However, the prescription of exercise may influence the magnitude of effect, possibility due to training specificity.[46]. Conversely, meta-analysis of QoL outcomes showed no marked differences between supervised exercise and home exercise programmes. In a recent randomised trial, McDermott et al (2018) considered the efficacy of home-based exercise (n = 99) with wearable technology and telephone coaching vs no exercise advice and found no difference home exercise and control.[65] Therefore, further research is required to evaluate the specific components of home-based interventions to maximise patient benefit (i.e. wearable technology, on-site visits etc).

Safety

There may be a misconception that exercise training may be unsafe in patients with PAD. Indeed, 70% of vascular surgeons in one survey thought that cardiovascular comorbidities or aorto-iliac stenosis or occlusions were relative contraindications to exercise.[66] Gommans et al (2015) explored the safety of supervised exercise training (via any exercise modality) and reviewed adverse event data from clinical trials.[67] Seventy-four trials were included, representing 82,725 hours of training in 2,876 patients with a mean age of 64 (range 54-76). Eight adverse events were reported, six of cardiac and two of non-cardiac origin and one fatal adverse event (myocardial infarction). This resulted in an all-cause complication rate of one event per 10,340 patient-hours. The total non-cardiac and cardiac event rate was one per 13,788 patients and one per 41,363 hours. The study concluded that supervised exercise training is safe for people with IC due to a low all-cause complication rate, and routine cardiac pre-screening is not required.[67] However, it should be noted that patients participating in clinical trials might not be a true representation of the overall population. This may be due to strict exclusion / inclusion criteria screening out patients with extensive co-morbidities. It would be beneficial to have observational data for adverse events in routine supervised exercise programmes, to fully elucidate the all-cause complication rates. In addition, it is important to note, that as a patient's exercise tolerance, pain tolerance and walking ability improve, this may begin to unmask underlying signs and symptoms of coronary artery disease. Whilst not routine practice, cardiac screening may also be considered when patients are engaging in an exercise modality that may not elicit claudication pain such as cycling or when they are engaging in higher intensity exercise programmes. In general, contra-indications to participation in an exercise programme include uncontrolled hypertension, unstable angina or other uncontrolled arrhythmias. Relative contraindications include known obstructive coronary disease, acquired or advance heart block. A comprehensive list of both absolute and relative contraindications can be found in the '*American College of Sports Medicine Guidelines for Exercise Testing and Prescription'*.[44,68]

APPLICATION TO PRACTICE

Recommendations for Exercise Training

All prospective patients should be clinically assessed, and risk stratified to ensure that they do not have any contraindications to the exercise therapy, and to document comorbidities that may need to be accounted for, in order to individualise the exercise programme. Patient ability and preference should also be taken into account when prescribing the exercise programme. Clinical assessment should be repeated as exercise tolerance improves to ensure that the training intensity is sufficient to ensure ongoing patient safety. Any exercise programme should ideally be delivered through an on-site supervised programme with clinical oversight. However, a facilitated, self-managed exercise programme involving behaviour change techniques is a reasonable alternative for patients who prefer this approach or are unable to access supervised exercise.[62] The core modality for supervised exercise programmes should be walking, however, other modes are also efficacious for those who cannot tolerate walking programmes, as outlined in table two. Alternative modes include arm cranking, cycling, pole-striding, and progressive resistance training. A structured programme should involve walking at an intensity that elicits moderate-to-strong claudication pain and should be conducted for a minimum of 3 months, involving at least three, 30-45-minute sessions per week. Initial exercise prescription should be based on actual baseline maximum walking distance. Further evidence-based recommendations for exercise training are provided in Table 1. However, if patients struggle with the maximum intensity of pain prescribed, then walking at lower pain levels will also lead to improvements in walking ability/distance.[33,53]

During exercise training sessions, acute responses to exercise should be monitored to inform the exercise prescription, including heart rate, blood pressure (in the first few exercise sessions), perceived exertion, and claudication pain. The continuous monitoring of blood pressure is not recommended but should be revaluated if the intensity or mode of exercise changes. It is recommended that heart rate may be monitored continuously and blood pressure, perceived exertion and claudication pain are recorded intermittently when the patient stops exercises (if interval walking) or if any signs or symptoms (such as dizziness are present). Finally, programme entry and exit assessments should be performed to determine changes in patient outcomes, including walking distance (primarily 6-minute walk test) and QoL.

To support the provision and uptake of exercise, alongside this guideline an infographic of key messages has been developed that may be used as a poster or handout in clinic; particularly where patients cannot access a supervised programme[69].

SUMMARY

Exercise training is a safe, effective and low-cost intervention for improving walking ability in patients with IC. Additional benefits may include improvements in QoL, muscle strength and cardiorespiratory fitness. Clinical guidelines advocate supervised exercise training as a primary therapy for IC, with walking as the primary modality. However, evidence is emerging for the role of various other modes of exercise including cycling and progressive resistance training to supplement walking training. In addition, there is emerging evidence for home-based exercise programmes. Revascularisation or drug treatment options should only be considered in patients if exercise training provides insufficient symptomatic relief.

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FIGURE LEGENDS

Table One. Vascular Surgery Guideline Recommendations for Exercise.

Table Two: Summary of Exercise Prescription Recommendations

Figure 1. Intermittent claudication due to peripheral artery disease. Reproduced from Peripheral Artery Disease, (3) with permission from BMJ Publishing Group Ltd. Note: Iliac or femoral artery disease can cause symptoms at multiple distal muscle sites.

Table One: Vascular Surgery Guideline Recommendations for Exercise

Recommendation	**Frequency**	**Intensity**	**Type**	**Time**	**Duration**	**Progression**	**Supervision**	**Location**	**Supplementary exercises**
Guideline									
TASC II, 2007 [15]	3 x per week (typically)	Speed and grade that induces claudication within 3-5 minutes.	Intermittent treadmill walking	30 minutes increasing up to 60 minutes	Not reported	Increase speed / grade if patient can walk for more than 10 minutes	Not reported	Not reported	Not reported
AHA / ACC, 2016 [17]	3 x per week	Maximum-moderate claudication	Intermittent walking	30 – 45 minutes per session, with warm up and cool down	Minimum of 12 weeks	Not reported	Supervised by a qualified healthcare professional	Hospital / outpatient facility	Not reported
ECS, 2017 [18]	Not reported	Not reported	Walking	Minimum 3h/week	At least 3 months	Not reported	Supervised	Not reported	Cycling, strength training and upper-arm ergometry
NICE 147,2018 [16]	Not reported	Maximal pain	Walking	2h/week	3 months	Not reported	Supervised	Not reported	Not reported
RACGP, 2013 [70]	3-5 x p/w	Pain	Intermittent walking	30 minutes increasing to 60 minutes	Not reported	Not reported	Supervised	Not reported	Not reported

Table Two: Summary of Exercise Prescription Recommendations

Exercise rationale	To improve walking capacity, claudication symptoms and quality of life, and for secondary prevention of cardiovascular disease
Provider	**The programme should have a designated clinical lead (e.g. vascular surgeon, physician or nurse specialist).** Exercise professionals who wish to work in this area should possess the essential competencies and minimum qualifications as per the country of work. Professional standards of accredited exercise physiologists should include detailed knowledge of pathophysiology, exercise physiology and exercise training for patients with IC. Some of this is specified in the following BACPR Position Statement (UK Based):http://www.bacpr.com/resources/51A_EPG_Position_Statement.pdf
Mode of delivery	The exercise should ideally be delivered through an on-site supervised programme. The exercise prescription should be individually-tailored based on an initial assessment; however, several patients may be supervised at the same time. A facilitated, self-managed exercise programme with embedded behaviour change techniques is a reasonable alternative for people who prefer this approach or are unable to access an on-site programme, or for longer-term benefit after a supervised programme is completed. Details of a structured education programme that promotes self-managed walking exercise can be found here[62]. Additional information for home-based exercises can be found here (https://circulationfoundation.org.uk/news/covid-19-special) **Unstructured, unsupervised exercise approaches that consist solely of basic advice to walk or exercise more are not effective.**
Setting	On-site programmes can be delivered in various settings including hospital- or community-based exercise physiology or physiotherapy clinics or community exercise facilities. Self-managed programmes can be conducted in a setting that suits the individual.
Materials	**Assessment tools:** Motorised treadmill with adjustable incline to allow incremental exercise testing (e.g. 'Gardner' protocol) to determine pain-free and maximum walking distances or, if unavailable, procedures and instructions for an alternative functional capacity test (e.g. 30 meter 6-minute corridor walk test); questionnaires for assessing patient-perceived ambulatory function (e.g. WELCH questionnaire), and generic and condition-specific quality of life (e.g. SF-36, VascuQol and Walking impairment questionnaires, respectively). Optional – equipment to assess vascular status (e.g. ankle-brachial index) and cardiovascular disease risk (e.g. blood pressure, lipid profile). **Exercise equipment:** Motorised treadmills with adjustable incline or space for over-ground walking (preferably indoor and air-conditioned). Optional for aerobic exercise – upper and lower limb ergometers. Optional for resistance exercise – weights machines, dumbbells. **Intensity-monitoring equipment:** 5-point claudication pain scale, exertion scale (e.g. 6–20 point Borg Rating of Perceived Exertion Scale), heart rate monitors, manual sphygmomanometer and stethoscope.
Walking exercise guidelines	**Programme duration:** At least 3 months **Frequency:** ≥3 times/week **Claudication pain endpoint:** Based on current evidence, patients should be advised to walk to the point of near-maximum leg pain (i.e. 4-5 on claudication pain scale); however, preliminary evidence suggests that walking only to the onset of ischemic leg pain may also be beneficial for patients reluctant to walk at higher levels of pain **Pattern:** Following a warm-up period, the patient should walk at a speed and grade that induces claudication pain within 3-5 minutes. The patient is instructed to stop walking and rest when his or her claudication pain reaches a moderate-to-strong level. When the claudication has abated, the patient resumes walking until a moderate-to-strong claudication pain recurs. This cycle of exercise and rest is ideally repeated for at least 30 minutes. In subsequent visits, the speed or

	grade of walking is increased if the patient is able to walk for ≥10 minutes without reaching moderate claudication pain. For those patients who start at a lower level of claudication pain (1-3/5), as the patient tolerates it, they should be encouraged to increase the intensity of pain achieved as a progression tool. **Duration per session:** Many patients with IC may need to start with just 10-15 minutes of walking exercise per session. In this situation, the duration of exercise should be increased by 5 minutes each week, until the patient is walking for at least 30 minutes per session. Patients who can walk for more than 30 minutes per session should be encouraged to increase the exercise duration to 45-60 minutes. They should also be encouraged to include other modes of exercise to work on improving cardiorespiratory fitness and muscular strength
Upper & lower limb ergometry	May be considered as alternative aerobic exercise strategies for improving walking ability and quality of life. May also have the potential to provide a greater cardiorespiratory stimulus than walking exercise in individuals with severe claudication. **Example protocol:** Ten sets of 2 minutes of upper or lower extremity ergometry conducted twice weekly for at least 3 months. Intensity should be moderate or Borg RPE 13-14 (6-20 scale)
Resistance exercise	Though evidence is increasing, resistance exercise is yet to be included in international guidelines as a sole therapy, it is purely recommended as an adjunct for now. It therefore should be considered as complementary (e.g. for targeting improved strength or reduced falls risk), but not as a replacement for aerobic exercise because its impact on walking ability appears modest at best. **Example protocol:** Moderate-to-high intensity (Borg exertion rating of 14-16), 6-8 exercises (Leg press, Knee flexion, knee extension, calf press, chest press, seated row) targeting the major muscle groups of the upper and lower body, 2-4 sets of 10-15 repetitions per set, 2-3 sessions per week.
Other	Circuit-based training may be a practical way of delivering a combination of aerobic and resistance exercises when circumstances necessitate group-based training and is an effective tool for improving both muscle strength and cardiorespiratory fitness, which are both related to reduced cardiovascular and all-cause mortality [71].
Safety issues	An initial risk assessment should occur as per Appendix E of the following ACPICR Standards document https://www.acpicr.com/data/Page_Downloads/ACPICRStandards.pdf . Exercise is contraindicated by foot ulcers and limb pain at rest (i.e. critical limb ischaemia). As patients increase their walking ability, there is the possibility that cardiac signs and symptoms may appear (e.g., dysrhythmia, angina). These events should prompt further clinical assessment to ensure safety continuing. Clinical assessment should also be considered when a patient undertakes a mode of exercise that is not limited by claudication pain.