Peripheral Artery Disease and Exercise

Indexing Metadata/Description

- **Title/condition:** Peripheral Artery Disease and Exercise
- **Synonyms:** Exercise and peripheral artery disease (PAD); artery disease, peripheral and exercise; vascular disease, peripheral and exercise; peripheral vascular disease (PVD) and exercise; lower extremity vascular occlusive disease and exercise; PAD and exercise; PVD and exercise; atherosclerotic peripheral vascular disease and exercise
- **Anatomical location/body part affected:** Commonly the abdominal aorta, pelvic, femoral, and tibial arteries; usually affects muscles (often the calf) of the lower extremity
- **Area(s) of specialty:** Cardiovascular rehabilitation, home health, acute care

**Description and overview**

- Peripheral artery disease (PAD) is a disease in which occlusive atherosclerotic lesions develop in the extremities, and it is a manifestation of a systemic atherosclerotic process.
- In PAD, there can be partial or total blockage in the arteries, and it is exclusive of the coronary and cerebral vessels.
- Arterial stenosis causes inadequate blood flow in distal limbs and results in the failure to meet metabolic demands during exertion.
- In the lower extremities (LE), lesions tend to occur in 3 anatomic segments: the aortoiliac segment, femoral-popliteal segment, and the infrapopliteal or tibial segment of the arterial tree.
- Research shows that exercise is important because it leads to decreased leg pain and the likelihood of improving general physical condition, but it is as yet unclear if it improves quality of life (QOL).
- Relevant definitions
  - **Claudication**
    - Pain in the calf of one or both legs that occurs during walking and is relieved only by rest.
  - **Acute arterial occlusion of a limb**
    - Rapid or sudden decrease in limb perfusion that threatens tissue viability
    - Might be due to an embolus or to thrombosis of a diseased atherosclerotic segment
    - Symptoms include pain, paralysis, pulselessness, mottling and pallor
    - Vascular emergency; immediate revascularization is required within 3 hours; by 6 hours, there is 100% risk of irreversible tissue damage
  - **Critical limb ischemia**
    - Defined by most vascular clinicians as lower extremity chronic ischemic rest pain, ulceration, or gangrene attributable to arterial occlusive disease
    - Chronic resting perfusion defect leads to the inability to adequately supply blood to sustain viability of the extremity
    - Bypass grafting is the primary technique of revascularization
    - Associated with the highest rate of amputation
  - **Intermittent claudication (IC):** transient leg pain due to poor circulation
Patients with PAD often report the onset of IC typically in the calf muscles first and during physical activity\(^{(56)}\).

Claudication pain promotes sedentary behavior and thus decreases physical functioning in activities of daily living (ADLs) as well as activity-related QOL\(^{(1,2)}\).

Diagnostic ultrasound measurement of the ankle-brachial index (ABI) is the most often used clinical tool to assess PAD severity. ABI is the comparison of blood pressures at the ankle and the arm. ABI of 0.90 or less is associated with reduced walking endurance and leisure-time activity, while a value below 0.4 indicates critical limb or severe ischemia\(^{(3,4,54)}\).

This Clinical Review highlights the prominent role of supervised exercise therapy for the medical management of lower-extremity PAD in patients with IC.

For further information, see Clinical Review...Peripheral Artery Disease (PAD); Item Number: T708878, and Clinical Review...Angina Pectoris, Stable; Item Number: T708896

ICD-9 codes

- 440.2 atherosclerosis of native arteries of the extremities
  - 440.20 atherosclerosis of native arteries of the extremities, unspecified
  - 440.21 atherosclerosis of native arteries of the extremities with intermittent claudication
  - 440.22 atherosclerosis of native arteries of the extremities with rest pain
  - 440.23 atherosclerosis of native arteries of the extremities with ulceration
  - 440.24 atherosclerosis of native arteries of the extremities with gangrene
  - 440.29 other atherosclerosis of native arteries of the extremities
- 440.3 atherosclerosis of bypass graft of the extremities
  - 440.30 atherosclerosis of unspecified bypass graft of the extremities
  - 440.31 atherosclerosis of autologous vein bypass graft of the extremities
  - 440.32 atherosclerosis of nonautologous biological bypass graft of the extremities
- 440.4 chronic total occlusion of artery of the extremities (effective October 1, 2007)
- 443.81 peripheral angiopathy in diseases classified elsewhere
- 444 arterial embolism and thrombosis
  - 444.0 embolism and thrombosis of abdominal aorta
  - 444.21 arterial embolism and thrombosis of upper extremity
  - 444.22 arterial embolism and thrombosis of lower extremity
  - 444.81 embolism and thrombosis of iliac artery
  - 444.89 embolism and thrombosis of other artery
  - 444.9 embolism and thrombosis of unspecified artery

ICD-10 codes

- I70.2 atherosclerosis of arteries of extremities
- I72 other aneurysm
  - I72.1 aneurysm of artery of upper extremity
  - I72.3 aneurysm of iliac artery
  - I72.4 aneurysm of artery of lower extremity
  - I72.8 aneurysm of other specified arteries
  - I72.9 aneurysm of unspecified site
- I73.9 peripheral vascular disease, unspecified
- I74 arterial embolism and thrombosis
  - I74.2 embolism and thrombosis of arteries of upper extremities
  - I74.3 embolism and thrombosis of arteries of lower extremities
  - I74.4 embolism and thrombosis of arteries of extremities, unspecified
  - I74.5 embolism and thrombosis of iliac artery
  - I74.8 embolism and thrombosis of other arteries
  - I74.9 embolism and thrombosis of unspecified artery
- I79.2 peripheral angiopathy in diseases classified elsewhere, such as
  - E10.5 insulin-dependent diabetes mellitus with peripheral circulatory complications
  - E11.5 non-insulin-dependent diabetes mellitus with peripheral circulatory complications
  - E12.5 malnutrition-related diabetes mellitus with peripheral circulatory complications
  - E13.5 other specified diabetes mellitus with peripheral circulatory complications
– E14.5 unspecified diabetes mellitus with peripheral circulatory complications

G-codes

• Mobility G-code set
  – G8978, Mobility: walking & moving around functional limitation, current status, at therapy episode outset and at reporting intervals
  – G8979, Mobility: walking and moving around functional limitation; projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  – G8980, Mobility: walking & moving around functional limitation, discharge status, at discharge from therapy or to end reporting

• Changing & Maintaining Body Position G-code set
  – G8981, Changing & Maintaining Body Position functional limitation, current status, at therapy episode outset and at reporting intervals
  – G8982, Changing & Maintaining Body Position functional limitation; projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  – G8983, Changing & Maintaining Body Position functional limitation, discharge status, at discharge from therapy or to end reporting

• Carrying, Moving & Handling Objects G-code set
  – G8984, Carrying, Moving & Handling Objects functional limitation, current status, at therapy episode outset and at reporting intervals
  – G8985, Carrying, Moving & Handling Objects functional limitation; projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  – G8986, Carrying, Moving & Handling Objects functional limitation, discharge status, at discharge from therapy or to end reporting

• Self Care G-code set
  – G8987, Self Care functional limitation, current status, at therapy episode outset and at reporting intervals
  – G8988, Self Care functional limitation; projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  – G8989, Self Care functional limitation, discharge status, at discharge from therapy or to end reporting

• Other PT/OT Primary G-code set
  – G8990, Other PT/OT Primary functional limitation, current status, at therapy episode outset and at reporting intervals
  – G8991, Other PT/OT Primary functional limitation; projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  – G8992, Other PT/OT Primary functional limitation, discharge status, at discharge from therapy or to end reporting

• Other PT/OT Subsequent G-code set
  – G8993, Other PT/OT Subsequent functional limitation, current status, at therapy episode outset and at reporting intervals
  – G8994, Other PT/OT Subsequent functional limitation; projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  – G8995, Other PT/OT Subsequent functional limitation, discharge status, at discharge from therapy or to end reporting

<table>
<thead>
<tr>
<th>G-code Modifier</th>
<th>Impairment Limitation Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH</td>
<td>0 percent impaired, limited or restricted</td>
</tr>
<tr>
<td>CI</td>
<td>At least 1 percent but less than 20 percent impaired, limited or restricted</td>
</tr>
<tr>
<td>CJ</td>
<td>At least 20 percent but less than 40 percent impaired, limited or restricted</td>
</tr>
<tr>
<td>CK</td>
<td>At least 40 percent but less than 60 percent impaired, limited or restricted</td>
</tr>
<tr>
<td>CL</td>
<td>At least 60 percent but less than 80 percent impaired, limited or restricted</td>
</tr>
<tr>
<td>CM</td>
<td>At least 80 percent but less than 100 percent impaired, limited or restricted</td>
</tr>
<tr>
<td>CN</td>
<td>100 percent impaired, limited or restricted</td>
</tr>
</tbody>
</table>

Source: http://www.cms.gov
Reimbursement: CPT code 93668 was approved in 2001 for programs that address supervised exercise programs for physical therapists (PTs) treating patients with PAD; however, some medical insurance companies might not cover supervised treadmill exercise training (35) Other issues or information regarding reimbursement have not been identified

Presentation/signs and symptoms (1-2)
- Patients might present with a history of chronic and reproducible activity-related IC
  - Described as burning, heaviness/deep fatigue, and/or cramping in the legs
  - Onset often begins in the calf muscles
  - Bilateral or unilateral
  - Pain might extend to proximal leg muscles (thigh and buttock) in severe cases
  - Pain is relieved by slowing or stopping the activity
  - Only present in 10% of patients with PAD, (54) In fact, the American Heart Association estimates that 75% of the 8-12 million Americans with PAD are asymptomatic (55)
- The intensity of IC pain typically increases with the intensity/speed and distance of leg exercise such as walking or cycling
- Weak lower extremity pulses and ABI≤90
- Bruit (vascular sound heard through auscultation when blood flow is abnormal) might be present over carotid arteries, abdominal aorta, and iliac and femoral arteries
- Patient might also present with resting leg pain, (54) nonhealing wounds, (54,55) and impotence/erectile dysfunction (54,56)

Causes, Pathogenesis, & Risk Factors

Causes (1,2)
- Atherosclerosis: usually most advanced in the iliac arteries and lower extremities. Patients with PAD might also have associated coronary artery disease (CAD) or carotid artery disease
- Buerger’s disease
- Vasculitides
- Popliteal artery entrapment
  - Consider in young adults with low risk of atherosclerosis
  - Usually due to slippage/encroachment of gastrocnemius tendon
  - Arteriogram normal with leg straight but abrupt occlusion with leg flexed
- Cystic adventitial disease (i.e., synovial fluid in adventitia) might cause IC in young people not at risk for atherosclerosis

Pathogenesis
- In patients with PAD, arterial stenosis causes inadequate blood flow in distal limbs and failure to meet the metabolic demand during exercise (54)
- The degree of ischemia is proportional to the size and proximity of the occlusion to the end organ (54)
- Acidic products of anaerobic metabolism build up within the muscle and result in claudication clinically (54)
- Arterial occlusion also causes significantly diminished distal pressure in patients with PAD due to atherosclerotic lesions (54)
- Stages of atherosclerosis
  - Atheroma – fibrofatty plaque within intima
  - Fatty streak – subintimal, cholesterol-laden macrophage and smooth muscle cells. Fatty streaks are common in the aortas of children older than 1 year
  - Fibrous plaque – extracellular matrix, might progress to obstruction
  - Complex plaque – intimal ulceration or intraplaque hemorrhage, occlusion, and emboli
- In an unselected elderly population (over 70 years of age), peripheral stenosis (≥ 50%) was more common in one leg only. Stenosis of the superficial femoral artery, anterior tibial artery, and posterior tibial artery was the major determinant of ABI < 0.9 in both legs (8)
- Plaque formation in PAD restricts the increase in arterial flow needed to supply the greater limb oxygen (O₂) demand of exercise. Consequently, O₂ supply to the affected limb can become insufficient, resulting in IC
- IC begins with the occurrence of muscle tissue anoxia and accumulation of metabolic products of anaerobiosis (e.g., lactic acid) and subsides after exercise as the O₂ supply-demand balance is restored
• Although ABI screening increases the frequency of PAD diagnosis compared to the history and physical exam, symptoms might not be evident at rest even when ABI ≤ 0.9. Exercise is the usual factor that triggers IC and the awareness of PAD. Also, exercise testing enhances the detection of PAD in patients with a normal ABI who have IC.

• Objective testing for IC includes walking tolerance time (speed and distance) on a treadmill and the 6-minute walk test (6MWT) for distance at a self-selected speed.

• In 384 men and women with ABI ≤ 0.90 followed for a median of 47 months, patients with greater sedentary hours per day and slower outdoor walking speed showed faster declines in walking speed (assessed by the 6MWT) and reduced calf muscle mass.

• Supervised exercise training is an important component of medical management for increasing the time of IC onset and for improving walking speed, walking distance, and quality of life.

• The physiological mechanism of increased walking tolerance in PAD after exercise training is unclear, but probably involves improved gait efficiency along with local muscle adaptations that reduce leg muscle O₂ demand for a given walking speed.

• During the last several decades, researchers have developed a better understanding of the contribution of inflammation to the pathophysiological mechanism of PAD.

  – Recently, researchers who conducted a study in the United States found an association between systemic inflammation and impairment of walking time in patients with PAD and IC, but further studies are needed to understand how this and other nonhemodynamic factors contribute to IC and to drive the development of new therapies.

• The endothelium plays a crucial role in vascular homeostasis and endothelial dysfunction might play a part in the development of PAD as it might express pro-inflammatory and pro-thrombotic features, activate oxidative reactions and stimulate a proliferative state. Flow-mediated dilation (FMD) is a measure of endothelial function and the general health of the endothelium is influenced by such factors as medications, diet and physical activity.

• Both male and female patients respond favorably to exercise training and gender differences in the benefits of exercise training appear minimal.

• In addition to pharmacotherapy to reduce IC, medical intervention is aimed at secondary prevention of atherosclerosis and therefore includes treatment (e.g., statins, antihypertensive medications) for existing atherogenic risk factors.

• Ramipril, an angiotensin-converting enzyme (ACE) inhibitor, was shown in an Australian randomized controlled trial (RCT, N=212) to significantly improve pain-free and maximum-tolerated treadmill walking time compared to placebo. Increased muscle blood flow was the postulated physiological mechanism of improvement.

Risk factors

• Conventional atherogenic risk factors (e.g., hypertension, elevated serum lipids, diabetes, physical inactivity, cigarette smoking, and obesity) are associated with the etiology of PAD.

  – African American ethnicity is a strong and independent risk factor for PAD.

• Based on cross-sectional study of 6,450 persons over 55 years of age, the following factors are implicated:

  – Current or former cigarette smoking: a common trait in PAD.

  – Diabetes mellitus.

  – Elevated fibrinogen level.

  – Low high-density lipoprotein (HDL) cholesterol.

  – Elevated systolic blood pressure (BP).

  – Age over 75 years.

  – Family history of PAD, heart disease, or stroke.

• Other risk factors: chronic kidney disease and hyperhomocysteinemia.

Overall Contraindications/Precautions

› Obtain physician clearance for patient to participate in individualized exercise training program; adhere to any parameters set by the physician for vitals and exercise intensity.

› Deep vein thrombosis (DVT) with or without critical limb ischemia contraindicates exercise.

› Acute limb ischemia is a medical emergency and any patient suspected of having this (see symptoms listed above, under Description) should be immediately referred to emergency services.
Ischemic leg pain at rest is a relative contraindication to exercise. However, critical limb ischemia should be immediately ruled out (especially in patients with diabetes, neuropathy, chronic renal failure, or limb infection) as risk of amputation is high\(^1\)\(^2\)

Multiple precautions might be warranted depending on any existing comorbidities, scope of disabilities, and weight-bearing restrictions from physician

See specific **Contraindications/precautions to examination** and **Contraindications/precautions** under Assessment/Plan of Care

**Examination**

**Contraindications/precautions to examination**

- Consult physician regarding signs/symptoms of DVT if patient has a painful, swollen calf and/or a red, warm calf\(^4\) and only resume exercises when physician clears patient
- Obtain physician order for restrictions on exercise if chronic DVT is present\(^4\)
- Consult physician if nonhealing wounds are present
- Screen patient for other symptoms that might limit exercise tolerance, such as foot pathology, non-healing LE wounds, arthritis, chest pain, shortness of breath, etc.
- Stop the exam if patient complains of chest pain, shortness of breath, abnormal fatigue, or dizziness
- In many cases, physician clearance and supervision are required for exercise testing

**History**

- **History of present illness/injury**
  - **Mechanism of injury or etiology of illness**
    - What are these symptoms and when did they begin? What has been the general progression of symptoms since onset?
    - What modifiable risk factors are present? For example, does patient smoke?\(^3\)
    - Does the patient complain of leg pain at rest and/or during exercise?\(^3\)
    - Is physical activity restricted by IC?
    - Does the history indicate that walking ability has worsened?
  - **Course of treatment**
    - **Medical management**
      - Have any complications, such as leg ulcers, thrombophlebitis, or gangrene, been treated?\(^3\)
      - Document any treatments for atherogenic risk factor reduction and the patient’s compliance
      - Conservative intervention
        - What treatments have been tried for rehabilitation?
        - Elastic compression garment might be used to reduce risk of postthrombotic syndrome in patients with recent DVT\(^5\)
      - Does patient follow a physician-prescribed home exercise program? If so, is it helping function?
    - **Surgical management**
      - Document any surgical/invasive interventions such as revascularization treatment (e.g., percutaneous transluminal angioplasty with/without stenting, bypass grafting)
      - For further information, see *Clinical Review...Peripheral Artery Disease (PAD)*, referenced above
    - **Medications for current illness/injury**
      - Determine what medications clinician has prescribed. Are they being taken and are they helping?
      - Conventional pharmacotherapy in PAD includes:\(^6\)
        - Statins for lowering serum low-density lipoprotein (LDL) cholesterol\(^7\)
        - Antiplatelet drugs such as aspirin or clopidogrel for reducing intravascular clotting\(^7\)
        - ACE inhibitors for lowering BP. Treatment with ramipril is associated with improved walking tolerance time to onset of IC\(^8\)
        - Beta blocker for reducing myocardial ischemia if CAD is present
        - Optimal glycemic control for patients with diabetes
    - **Diagnostic tests completed:** Usual tests for this condition are the following:
- ABI\(^{(17,53,54,55,56)}\)
- Less than or equal to 0.9 in repeated measures is common using Doppler method
- Auscultatory method can be used, but the Doppler method is the gold standard
- Magnetic resonance angiography (MRA)\(^{(18,56)}\) and computed tomography angiography (CTA) are only required when symptoms require intervention\(^{(56)}\)
- Rose questionnaire for IC\(^{(19)}\)
- Physical examination includes:
  - Palpation of peripheral pulses, abdominal examination for aortic aneurysm, BP measured in both arms, auscultation for bruits in the neck and over the clavicles, abdomen and femoral pulses, assessment of skin temperature and color, assessment of any wounds\(^{(53-55)}\)
  - Duplex ultrasound\(^{(17,53,54,56)}\)
- Pulse volume recording\(^{(53,56)}\)
- Angiography\(^{(54)}\)
- Transcutaneous oximetry\(^{(55)}\)
- Systolic blood pressures of the foot\(^{(55)}\)
- Brachial artery flow-mediatedendothelium-dependent vasodilation (FMD) to assess arterial endothelial function (EF)\(^{(52)}\)
- Researchers who conducted a study in the United States found significant association between EF and disease severity as well as walking disability
- Diagnostic tests to rule out neurogenic causes and to assess tissue changes include spinal x-ray, magnetic resonance imaging (MRI), computed tomography (CT), and electrodiagnostic testing\(^{(52)}\)
- 6MWT\(^{(9,17,53)}\)
  - Reliably measures the functional severity of IC
  - Distance walked at onset of leg pain is referred to as “claudication distance” or pain-free distance, whereas maximum distance implies pain tolerance point
  - Treadmill exercise test\(^{(47,54)}\)
- Other tests that might be performed (possibly to identify modifiable risk factors) include: serum glucose screening, fasting lipid profile,\(^{(54)}\) and vitamin D levels (low levels have been associated with faster decline in functional measures in individuals with PAD)\(^{(39)}\)

**Home remedies/alternative therapies**: Document any use of home remedies (e.g., ice or heating pack) or alternative therapies (e.g., acupuncture) and whether or not they help
- Acupuncture, biofeedback, chelation therapy, and supplements such as Gingko Biloba, omega-3 fatty acids, and vitamin E have been studied\(^{(54)}\)

**Previous therapy**: Document whether patient has had occupational or physical therapy for this or other conditions and what specific treatments were helpful or not helpful. Also inquire about cardiac or pulmonary rehabilitation

**Aggravating/easing factors** (and length of time each item is performed before the symptoms come on or are eased): Document factors (such as ambulation) that aggravate the patient’s symptoms. Do the symptoms relieve with rest?

**Body chart**: Use body chart to document location and nature of symptoms\(^{(55)}\)

- Referral pattern of pain from specific arteries:
  - Abdominal aorta – buttock
  - Iliac artery – hip/thigh
  - Superficial femoral artery and/or posterior and anterior tibial arteries – calf

**Nature of symptoms**: Document nature of symptoms (constant vs. intermittent, sharp, dull, aching, burning, numbness, tingling)
- Claudication is most commonly described as deep fatigue, aching, or cramping pain
- Clinical presentation varies\(^{(1,2)}\)

**Rating of symptoms**: Use a visual analog scale (VAS) or 0-10 scale to assess symptoms at their best, at their worst, and at the moment (specifically address if pain is present now and how much). The onset and progression of exercise-related symptoms can be rated for perceived exertion (RPE) using the Borg Rating of Perceived Exertion (RPE) Scale
- **Pattern of symptoms**: Document changes in symptoms throughout the day and night, if any (A.M., mid-day, P.M., night); also document changes in symptoms due to weather or other external variables

- **Sleep disturbance**: Document number of times awakened at night. Patients with PAD typically have pain with ambulation and are not woken from pain at night; document any sleep pathology such as sleep apnea and current treatment

- **Other symptoms**: Document other symptoms patient might be experiencing that could exacerbate the condition and/or symptoms that could be indicative of a need to refer to physician (dizziness, bowel/bladder/sexual dysfunction, saddle anesthesia, symptoms of DVT)

- **Respiratory status**: Does the patient need supplemental oxygen? Are respiratory symptoms evident when walking? Is there a history of pulmonary embolism or any other respiratory compromise (e.g., emphysema or other chronic obstructive pulmonary disease [COPD], especially if the patient is a smoker)

- **Barriers to learning**
  - Are there any barriers to learning? Yes__ No__
  - If Yes, describe __________________________

• **Medical history**

  – **Past medical history**
    - **Previous history of same/similar diagnosis**: Has patient had discomfort with ambulation in the past? Does patient have a history of any other arterial disease? History of nonhealing wounds?
    - It is advised that patients over 50 be asked if they have a first-order relative with an abdominal aortic aneurysm

  - **Comorbid diagnoses**: Ask patient about other problems, including pulmonary disease, cardiovascular disease (CVD), diabetes, cancer, heart disease, psychiatric disorders, orthopedic disorders, etc.
    - Researchers in Brazil found that CVD is associated with a lower total walking distance in patients with PAD, especially when clustered with hypertension and diabetes
    - In the presence of diabetes, PAD patients are at increased risk for disease progression to critical leg ischemia, LE amputation, and cardiovascular events
    - Researchers in the United States found type 2 diabetes mellitus attenuated improvements in endothelial function, net plasma nitrate response and pain free walking time in patients with PAD compared to those without, following 3 months of exercise training
    - Researchers in the United States also found that women with PAD and diabetes respond particularly poorly to exercise rehabilitation

  - **Medications previously prescribed**: Obtain a comprehensive list of medications prescribed and/or being taken (including over-the-counter drugs)

  - **Other symptoms**: Ask patient about any other symptoms that can reduce physical activity

• **Social/occupational history**

  – **Patient’s goals**: Document what the patient hopes to accomplish with therapy and in general

  – **Vocation/avocation and associated repetitive behaviors, if any**: Does the patient participate in recreational activities? Does the patient smoke or drink alcoholic beverages on a regular basis? Document the patient’s regular physical and occupational activities and if they involve walking (e.g., mailman)

  – **Functional limitations/assistance with ADLs/adaptive equipment**: Functional limitations include decreased ambulation distance. Sedentary behavior can lead to limitations in other ADLs secondary to weakness and decreased endurance. Ask patient to specify limitations and any adaptive equipment used, including assistive devices

  – **Living environment**: Stairs, number of floors in home, with whom patient lives, caregivers, etc. Identify if there are barriers to independence in the home; any modifications necessary?

› **Relevant tests and measures**: (While tests and measures are listed in alphabetical order, sequencing should be appropriate to patient medical condition, functional status, and setting)

• **Anthropometric characteristics**

  – Determine height, weight, and body mass index (BMI)

  – Determine whether patient is overweight or obese and make recommendations for weight loss, if indicated

• **Assistive and adaptive devices**: Does the patient use a cane, walker or other ambulatory device? Is the device properly fitted and being used correctly? Does patient use any adaptive devices such as an elevated toilet seat or grab bars at home?

• **Balance**: Assess static and dynamic balance. Fall risk might be assessed using Berg Balance Scale (BBS) or Tinetti test
• **Cardiorespiratory function and endurance**
  – Assess vital signs, including pulse rate, BP, and respiratory rate
  – Administer 6MWT for claudication distance\(^{(20)}\)
    - Use a lap track, if available
    - Ask patient to give his or her best effort
    - At any time, patient might slow to relieve discomfort or stop the test due to intolerance
    - Note claudication distance (if unable to complete 6 minutes)

• **Circulation**
  – Assess dorsalis pedis and posterior tibial pulses\(^{(54)}\)
  – ABI
    - Comparison of systolic BP in the dorsalis pedis/posterior tibial arteries and the brachial artery using a handheld Doppler device\(^{(21)}\)
    - In the absence of a Doppler device, the ABI can be indirectly assessed using a sphygmomanometer (i.e., divide the average of three systolic pressure readings at the brachial artery into the average of three systolic pressure readings of the affected leg)\(^{(22)}\)
    - The American Diabetes Association recommends ABI screening for diabetic patients over the age of 50 and younger diabetic patients with other risk factors for PAD\(^{(21)}\)

• **Ergonomics/body mechanics:** If indicated, assess body mechanics during occupational/ADL demands, while observing posture, efficiency, and safety. Document any IC occurring during occupational tasks

• **Functional mobility** (including transfers, etc.): Does IC or other symptoms reduce functional mobility? If so, assess mobility using FIM and/or Timed Up and Go (TUG) test

• **Gait/locomotion:** Observe for gait abnormalities or patterns that might reduce walking efficiency. As indicated, assess safety with Dynamic Gait Index (DGI). Maximum walking distance (MWD) is defined as the distance covered before limb pain or discomfort forces the patient to stop walking\(^{(50)}\). Maximum walking time (MWT) is defined as the amount of time the patient can walk before onset of symptoms.\(^{(48)}\) The Walking Impairment Questionnaire (WIQ) might be used to document self-reported walking distance, walking speed, and stair-climbing ability\(^{(1)}\)

• **Joint integrity and mobility:** Assess joint mobility, as indicated. No joint abnormality is expected unless secondary pathology such as osteoarthritis is present

• **Muscle strength:** Assess functional strength. Manual muscle testing might show weakness secondary to disuse atrophy in the affected limb

• **Observation/inspection/palpation** (including skin assessment): Observe for color changes (pallor, cyanosis, rubor), nonhealing ulcers, muscle atrophy, hair loss in distal extremities, thickened nails, smooth shiny skin, bruits\(^{(54)}\)
  – Regularly inspect skin for any non-healing wounds and closely monitor

• **Palpation:** Check for bilateral differences in skin temperature of the legs/feet

• **Range of motion:** Assess flexibility and functional range of motion (ROM) of the lower extremities. Decreased physical activity, muscle shortening, and secondary pathologies might affect lower extremity flexibility

• **Posture:** Assess for excessive trunk lean or obvious postural asymmetry that might affect posture during gait

• **Self-care/activities of daily living** (objective testing): Does any disability interfere with self-care? If so, document the problems, use Barthel Index for objective measure

• **Sensory testing:** Assess proprioception and skin sensation to light touch, deep pressure, two-point discrimination, and temperature, as indicated

• **Special tests**\(^{(23)}\)
  – PAD QoL Questionnaire\(^{(1,2)}\)
  – Clinical features suggestive of PAD
    - Weak or absent pedal pulse
    - Unilateral coolness of extremity
    - Prolonged venous filling time
    - Femoral or iliac artery bruit
    - Positive Buerger test (increased pain on hanging affected leg over side of bed)
  – Clinical features that are helpful but not specific for diagnosis of PAD
    - Capillary refill test
- Foot discoloration
- Atrophic skin
- Hairless extremities
- Warm knees
  - SF-36 (43)
  - SF-12 (51)
  - Walking Estimated-Limitation Calculated by History (WELCH) (41)
  - WIQ (45, 51)

**Assessment/Plan of Care**

**Contraindications/precautions**

- DVT, critical limb ischemia, and other comorbidities that increase cardiovascular risk should be cleared by physician before beginning exercise activity
- Electrotherapeutic modalities are not indicated for PAD, but check on contraindications/precautions for use of modalities for other musculoskeletal problems, including osteoarthritis, as might be indicated
- Patients with IC and arthritis might report increased joint pain on ambulation (24)
- These patients might be at increased risk for falls. Follow facility protocols for fall prevention and post fall prevention instructions at bedside, if inpatient. Ensure that patient and family/caregivers are aware of the potential for falls and educated about fall prevention strategies. If applicable, discharge criteria should include independence with fall prevention strategies

**Diagnosis/need for treatment:** PAD/impaired walking speed and endurance and reduced claudication distance; reduced lower extremity strength and flexibility associated with physical inactivity; potential functional deficits in posture, balance, functional mobility, self-care performance, and gait mechanics; potential fall risk; potential overweight

**Rule out (1, 2, 25)**

- Neurogenic causes
  - Herniated disc
  - Spinal stenosis (neurogenic claudication)
  - Peripheral radiculopathy
- DVT
- Popliteal entrapment syndrome
- Differential diagnosis of exercise-induced leg pain includes: (25)
  - Spinal stenosis
  - Medial tibial stress syndrome
  - Periostitis
  - Tibial stress fracture
  - Achilles tendinitis
  - Fibular stress fracture
  - Compartment syndrome (deep posterior, exertional, or recurrent anterior compartment syndrome)
  - Fascial hernia
  - Peripheral neuropathy (e.g., common peroneal nerve compression)
  - Venous stasis

**Prognosis**

- Natural progression of PAD includes gradual reduction in walking tolerance (e.g., 6MWT). However, only a minority of patients who receive optimal medical treatment experience severe leg pain at rest or require amputation (1, 2)
  - The prognosis for motivated patients with isolated superficial femoral artery is excellent (56)
  - Among patients with IC: (54)
    - 15-20% will experience worsening claudication
    - 5-10% will undergo LE bypass surgery
    - 2-5% will require amputation (rates for patients with diabetes and those who smoke are much higher)
– 12% of patients with critical limb ischemia require amputation within 3 months of diagnosis. Patients with critical limb ischemia have a 9% mortality rate at 3 months after diagnosis and 22% mortality rate at 1 year\(^{25}\)

– Mortality among patients with PAD can be as high as 50%\(^{56}\)

• Sedentary behavior and slow walking speed in the community are associated with faster functional decline and adverse changes in calf muscle\(^{10}\)
  – Based on an observational study of 384 patients with ABI ≤0.90 who were followed for a median of 47 months
  – Patients with slower walking speed outside the home and/or greater hours sitting per day had greater declines in fast-paced and usual-paced 4-meter walking speed
  – Greater sedentary hours were also associated with a faster decline in calf muscle density (an indicator of muscle mass) measured by CT scans

• Supervised exercise training is associated with decreased cardiovascular risk factors, increased distance to claudication, and increased 6MWT\(^{26,27}\)

Referral to other disciplines: Nutritionist for dietary modification and weight loss; wound care specialist and/or podiatrist as indicated for diabetic ulcers; occupational therapist for disability in ADLs; cardiac rehabilitation specialist; smoking cessation program

Other considerations
• Walking poles can enable patients with PAD to walk at increased speed and stride length with less pressure on the knee joints and allows more relaxation between toe off and heel strike;\(^{28-29}\), however, an RCT conducted in the United States found that traditional walking was superior to walking with poles in increasing endurance, as measured by a constant workrate treadmill test\(^{37}\)

• Note whether patient has additional symptoms (e.g., foot pathology, arthritis, chest pain, shortness of breath) that interfere with or restrict the ability to exercise

• Clinicians should not expect increased ABI or indices of improved peripheral arterial blood flow after exercise training even though 6MWT might increase\(^{30}\)

Treatment summary
• Compilation of the 2005 and 2011 practice guidelines for the management of patients with PAD from the American College of Cardiology/American Heart Association recommend supervised exercise training (treadmill or track walking, a minimum of 30 to 45 min, at least 3 times per week for a minimum of 12 weeks) as an initial treatment modality for patients with IC\(^{53}\)

• Researchers who conducted a prospective study in Poland found that 12 weeks of supervised treadmill walking training resulted in prolonged asymptomatic walking distance (as measured by MWT) as well as improved flow-mediated dilation, indicating improved endothelial function\(^{48}\)

• Researchers who conducted a small study in Israel\(n=15\) found patients with PAD who underwent treatment that included pre-programmed sequences of oscillations (similar to whole body vibration) demonstrated improved MWD, microcirculation, tissue oxygenation, and carbon dioxide clearance; however, they report that more studies are needed to determine the underlying mechanism and long-term clinical effects and effect on QOL\(^{43}\)

• 6MWT reliably increases with exercise training in both nonsmokers and smokers, mostly during the first 6 months of training\(^{31}\)
  – Based on an Italian prospective study of 500 patients with IC
  – Increased in nonsmokers by 33.7 meters per month of training and in smokers by 43 meters per month
  – 6MWT did not improve significantly in the sedentary controls

• Aerobic exercise other than walking (e.g., stationary cycling, aquatic therapy, rowing, upper-body cycling) can also improve claudication distance. In addition, progressive resistance exercise (PRE) training appears promising based on a few trials\(^{32}\)
  – Based on a 2011 systematic review with meta-analysis of 36 RCTs, including 1,644 patients (73% male)
  – 32 aerobic exercise trials (20 involved walk training) and 4 trials of PRE or individually graded weight lifting
  – Walking ability or maximum distance significantly improved in most trials, irrespective of exercise mode, intensity of training, and pain level

• Clinic-based supervised exercise might be more effective for improving claudication distance than unsupervised or “go home and walk” exercise programs;\(^{6,7,33}\) however, researchers who conducted an RCT in the United States found a
6 month group-mediated cognitive behavioral (GMCB) intervention in which the participants performed home-based walking exercises on their own showed increased improvement of 6MWT and WIQ over controls\(^{(51)}\)

–GMCB group attended weekly 90 minute group support meetings that promoted exercise, the control group attended weekly lectures on topics unrelated to exercise
–Benefits continued for the intervention group 12 months later, 6 months after the program ended

• Compared to supervised exercise provided by PTs in outpatient clinics, use of a pedometer for daily feedback did not further enhance improvements in claudication distance, WIQ scores, or quality of life\(^{(6)}\)
  –Based on a Dutch RCT of 304 patients
• To optimize the improvement in claudication distance, physical training programs should consist of at least 2 exercise sessions per week, each lasting over 30 minutes, for the first 3 months\(^{(33)}\)
• Concurrent leg strength training (ST) and plantar flexion endurance training (PFET) might improve physical work capacity in patients with PAD\(^{(34)}\)
  –Based on a small Norwegian trial of 10 patients in the exercise group and 10 controls
  –Exercise consisted of ST on a leg-press machine and PFET on a cycle ergometer 3 times per week for 8 weeks
  –Aerobic fitness (peak \(O_2\) uptake on treadmill testing) improved an average of 12.7% while maximal leg-press strength improved 38.3%
  –No adverse effects of the training occurred
• A Cochrane systematic review published in 2013 found a statistically significant benefit of supervised exercise therapy (SET) on treadmill walking distance (maximal and pain-free) compared with nonsupervised regimens for patients with PAD\(^{(38)}\)
• Researchers who conducted a small randomized crossover trial in Brazil (n=17) found that a single bout of resistance exercise decreased blood pressure and cardiac work for one hour after exercise in patients with PAD; however, these cardiovascular benefits were short term and were not maintained under ambulatory conditions\(^{(45)}\)
• True low and high intensity whole body resistance training and their effects on PAD have not been studied and resistance training in general is understudied\(^{(44)}\)

<table>
<thead>
<tr>
<th>Problem</th>
<th>Goal</th>
<th>Intervention</th>
<th>Expected Progression</th>
<th>Home Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced walking distance due to leg pain and impaired endurance</td>
<td>Increase claudication distance and walking endurance</td>
<td><strong>Supervised exercise training</strong>&lt;br&gt;30-min sessions at least 2 times per week for 3 months; treadmill or track walking training(^{(48,51,53)}), other non-walking aerobic exercises(^{(32)}), Cognitive behavior intervention(^{(51)})</td>
<td>Increase exercise intensity and duration per patient’s tolerance</td>
<td>Encourage patient to walk as much as tolerated at home; family/caregiver education</td>
</tr>
<tr>
<td>Reduced lower extremity flexibility and strength</td>
<td>Improve ROM and strength</td>
<td><strong>Functional training</strong></td>
<td>Progress per patient’s tolerance</td>
<td>Provide patient with instructions for home exercises</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>--------------------------</td>
<td>-------------------------</td>
<td>-------------------------------</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>Abnormal or inefficient gait pattern</td>
<td>Improve gait efficiency</td>
<td>Gait training with focus on efficient stride length and rate and normalizing gait pattern</td>
<td>As indicated</td>
<td>Encourage focus on gait efficiency when walking at home</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Deficits in posture and balance that increase risk of falls</th>
<th>Reduce fall risk, as indicated</th>
<th><strong>Therapeutic interventions</strong></th>
<th>Progress as indicated for each unique patient</th>
<th>Provide instructions for complementary exercises that are safe to perform at home</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Posture re-education; balance and proprioception training</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>High BMI (overweight)</th>
<th>Independent with management in weight loss and maintenance</th>
<th>Interventions focused on increasing physical activity; referral to dietitian, smoking cessation program</th>
<th>N/A</th>
<th>Structured home exercise program; patient and family education on risk factors and adherence to modifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other modifiable risk factors (e.g., smoking)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Desired Outcomes/Outcome Measures**

- Desired outcomes and associated measures:
  - Increased claudication distance/time to onset of IC
    - MWD, MWT, 6MWT, treadmill test, WIQ, WELCH
  - Increased walking speed
    - 4-meter walk test
  - Increased lower extremity strength
    - Manual or dynometric strength measurements
  - Improved lower extremity flexibility
    - Goniometry, flexibility testing
  - Improved balance and safety
    - Berg Balance scale, Tinetti
  - Improved safety with ambulation
    - DGI
  - Improved functional mobility and self-care
    - TUG, FIM, Barthel Index
  - Weight loss, as indicated
    - BMI
  - Improved quality of life
    - PAD QOL Questionnaire, SF-36, SF-12

**Maintenance or Prevention**

- Patient education on foot care, especially in the diabetic population
Patient Education

- American Heart Association Web site “About Peripheral Artery Disease,” http://www.heart.org/HEARTORG/Conditions/More/PeripheralArteryDisease/About-Peripheral-Artery-Disease-PAD_UCM_301364.jsp

Coding Matrix

| References are rated using the following codes, listed in order of strength: |
|-----------------------------|-----------------------------|-----------------------------|
| M Published meta-analysis   | RV Published review of the literature | PP Policies, procedures, protocols |
| SR Published systematic or integrative literature review | RU Published research utilization report | X Practice exemplars, stories, opinions |
| RCT Published research (randomized controlled trial) | QI Published quality improvement report | GI General or background information/texts/reports |
| R Published research (not randomized controlled trial) | L Legislation | U Unpublished research, posters, presentations or other such materials |
| C Case histories, case studies | PGR Published government report | CP Conference proceedings, abstracts, presentation |
| G Published guidelines | PFR Published funded report | |

References

10. McDermott MM, Liu K, Ferrucci L, Greater sedentary hours and slower walking speed outside the home predict faster declines in functioning and adverse calf muscle changes in peripheral arterial disease. *J Am Coll Cardiol*. 2011;57(23):2356-2364. (R)