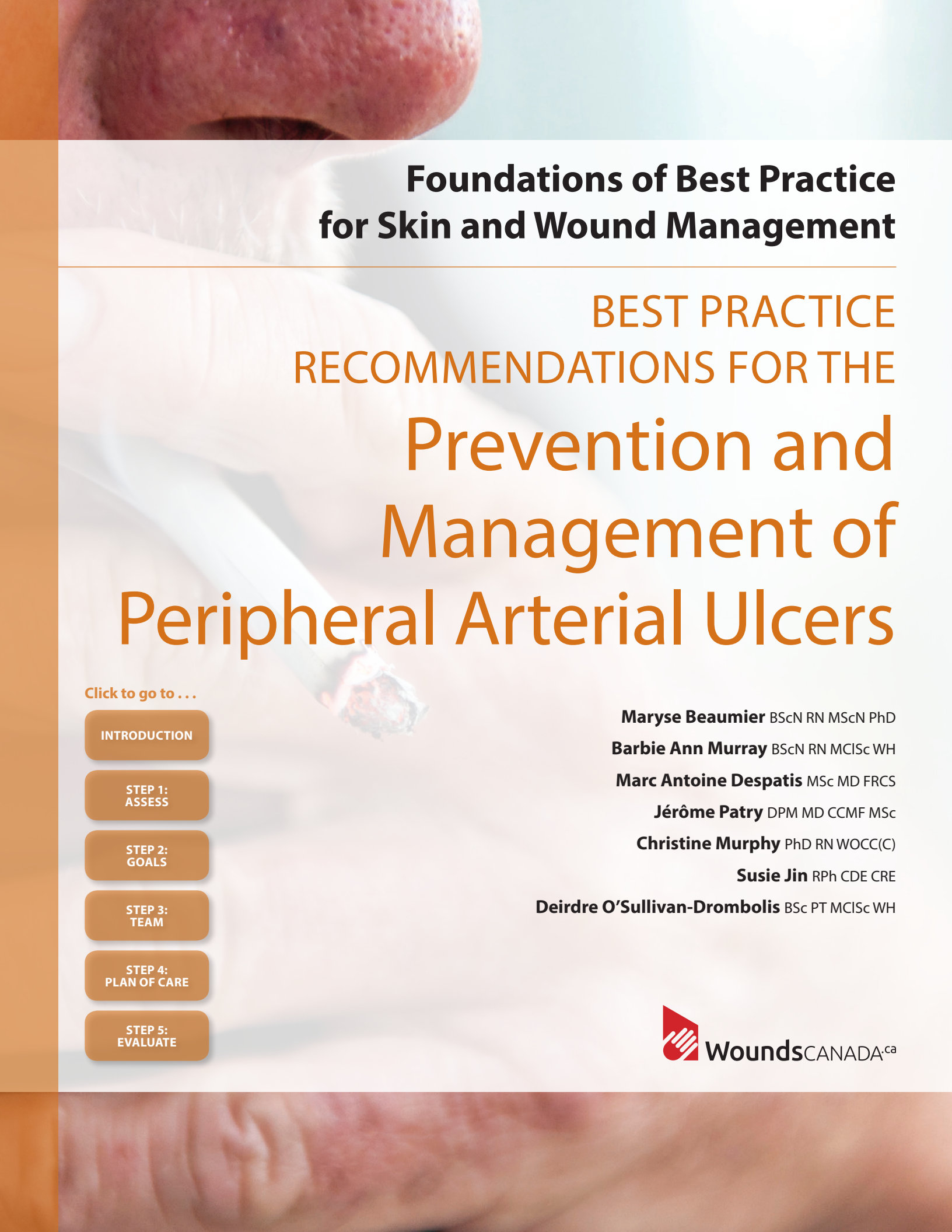

Foundations of Best Practice for Skin and Wound Management

BEST PRACTICE RECOMMENDATIONS FOR THE Prevention and Management of Peripheral Arterial Ulcers

Click to go to . . .

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Introduction

Introduction

This paper is dedicated to the prevention and management of peripheral arterial ulcers, specifically those of the lower extremity. Historically, the main recommendations for the management of peripheral arterial ulcers have focused on two primary objectives: determining if there is adequate blood flow to heal the wound, and assessing for signs and symptoms of peripheral arterial disease (PAD).[1]

The prevalence of PAD is 14.9% for those ≥ 45 years of age, and 15–20% for those > 70 years.[2–6] A recent meta-analysis reported a conservative estimate of more than 202 million individuals world-wide diagnosed with PAD, and a 23.5% increase in PAD prevalence during the first decade of the new millennium.[7] This staggering increase in prevalence, along with the impact of associated comorbidities, demands a responsive approach to ensure the early detection and treatment of PAD—particularly since arterial insufficiency is identified as the primary causative factor for arterial ulcers.

Though this paper primarily refers to the management of lower extremity arterial ulcers, much of the content is also applicable to upper extremity arterial ulcers.

Although PAD is a chronic disease that can impact both the upper and lower extremities, it is more common in the lower limbs. Lower extremity arterial disease can also include diseases in the abdominal aorta and in the iliac arteries, which may contribute to or result in arterial insufficiency. Arterial disease occurring in the lower extremity is now more accurately referred to as lower extremity arterial disease (LEAD) and will be referred to as such in this paper except when the cited reference specifically discusses PAD. PAD/LEAD often results in tissue ischemia and ulceration and is a significant barrier to the wound healing process.[4,8] Patients with LEAD may develop spontaneous ulcerations that fail to heal or that progress to gangrene and/or critical limb ischemia (CLI).[8] CLI is now more accurately being referred to as critical limb-threatening ischemia (CLTI), and will be referred to as such throughout this paper.[9]

Arterial insufficiency inhibits the wound healing process as tissues are poorly perfused and the delivery of systemic antimicrobials is often compromised as a result of the lack of blood supply to the wound site.[10–12] Therefore, addressing the underlying PAD/LEAD is essential when caring for patients who present with lower extremity ulcers.[4,8] The European Study Group in Diabetes and the Lower Extremity (EURODALE) study, involving a cohort of 1,088 patients with diabetic foot ulcers (DFUs) from 14 different centres in Europe, reported an increase in impaired healing when PAD co-existed with diabetes mellitus (DM).[13] Patients diagnosed with both PAD and DM have been shown to be seven to 15 times more likely to experience major amputation following the development of an ulcer, as compared with those without DM.[14–16] The prevalence of lower extremity amputation is often used as an indicator to measure the quality of care patients have received.[17–18]

The Best Practice Recommendations for the Prevention and Management of Peripheral Arterial Ulcers is intended to be a summary of the most current best practice guidelines (BPGs) and other sources of relevant evidence dedicated to the prevention and management of peripheral arterial ulcers. This best practice recommendation (BPR) document was written to support clinicians in the development and implementation of plans of care designed to optimize the prevention and management of arterial ulcers, and to minimize unnecessary limb loss. The optimal approach to the prevention and management of arterial ulcers is to treat the underlying disease and to avoid infection to the wound.[8] Unfortunately, this is not always possible, considering that 50% of patients with PAD are asymptomatic, or the LEAD is masked and remains undetected.[4] In addition, PAD awareness is not yet widespread, and timely referrals to

vascular specialists for investigation often come too late to save the limb or prevent extensive tissue loss and suffering.[2,12,19]

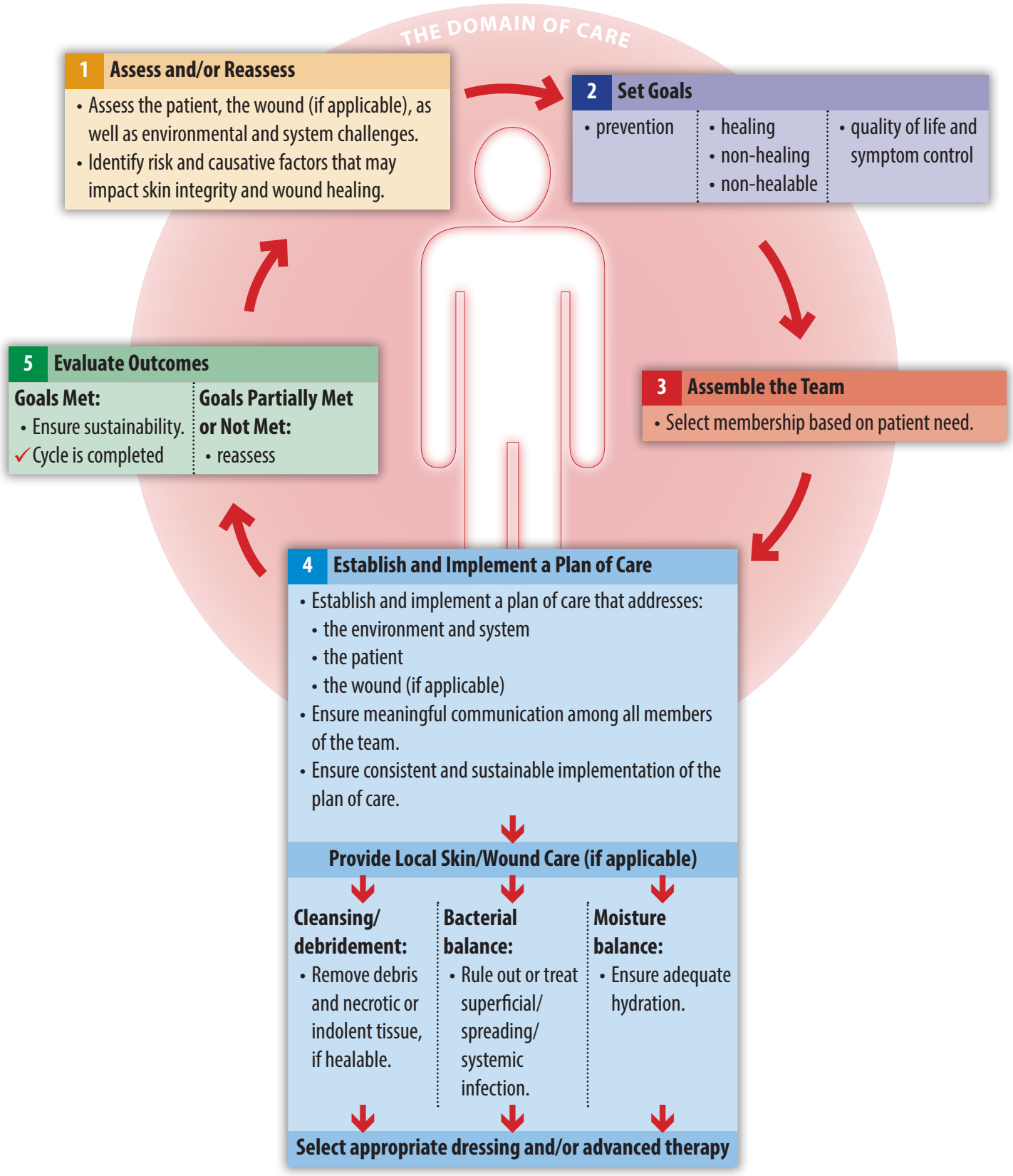
The Wound Prevention and Management Cycle

This BPR for the Prevention and Management of Arterial Ulcers offers a practical, easy-to-follow guide that incorporates the best available evidence and a structured process designed to support a patient-centred and interprofessional approach to care. The Wound Prevention and Management Cycle (see Figure 1) provides health-care professionals with a systematic approach in the development of customized care plans aimed at the prevention and management of arterial wounds. The Wound Prevention and Management Cycle incorporates self-management along with prevention and chronic disease management for patients diagnosed with LEAD.

The recommendations in this document are based on the best available evidence and most current BPGs available worldwide. These recommendations are intended to support members of the health-care team, including the patient and their family, in the planning and delivery of care specific to LEAD as well as associated arterial ulcers. Two foundational papers supplement this document with additional evidence-based information and recommendations general for all wound types:

- Skin: Anatomy, Physiology and Wound Healing,[20] and
- Best Practice Recommendations for the Prevention and Management of Wounds.[21]

Figure 1: The Wound Prevention and Management Cycle



The three guiding principles within these BPRs that support effective prevention and management of skin breakdown are as follows:

1. The use of a logical and systematic approach, regardless of the specifics, to prevent and manage skin breakdown
2. The constant, accurate and multidirectional flow of meaningful information with the team and across care settings
3. The patient as the core of all decision making

Quick Reference Guide

The quick reference guide (QRG) (see Table 1) provides the recommendations associated with the five steps in the Wound Prevention and Management Cycle (see Figure1). These recommendations are discussed with the supporting evidence. Due to the lack of available BPGs specific to the management of arterial ulcers, the evidence has been

Table 1: Wound Prevention and Management Quick Reference Guide

Step		Recommendation	Evidence
1	**Assess and/or Reassess**	1.1 Select and use validated patient assessment tools.	Ia, Ib, IIa, IIb, III
		1.2 Identify risk and causative factors that may impact skin integrity and wound healing.	Ib, IIa, IIb
		1.2.1 Patient: Physical, emotional and lifestyle	IIa, IIb
		1.2.2 Environmental: Socio-economic, care setting, potential for self-management	III, IV
		1.2.3 Systems: Health-care support and communication	III, IV
		1.3 Complete a wound assessment, if applicable.	
2	**Set Goals**	2.1 Set goals for prevention, healing, non-healing and non-healable wounds.	Ia, IIa
		2.1.1 Identify goals based on prevention or healability of wounds.	Ia, IIa, IIb
		2.1.2 Identify quality-of-life and symptom-control goals.	Ia, Ib, IIa, IIb
3	**Assemble the Team**	3.1 Identify appropriate health-care professionals and service providers.	Ia, Ib, Ia, IIb, III
		3.2 Enlist the patient and their family and caregivers as part of the team.	Ia, IIb, III
		3.3 Ensure organizational and system support.	Ia, Ib, III, IV
4	**Establish and Implement a Plan of Care**	4.1 Identify and implement an evidence-informed plan to correct the causes or co-factors that affect skin integrity, including patient needs (physical, emotional and social), the wound (if applicable) and environmental/system challenges.	Ia, IIa, IIb, III, IV
		4.2 Optimize the local wound environment aided through	III, IV
		4.2.1 Cleansing	Ia, Ib, IIa, IIb, III, IV
		4.2.2 Debriding	IIa, IIb, III
		4.2.3 Managing bacterial balance	IIa, IIb
		4.2.4 Managing moisture balance	
		4.3 Select the appropriate dressings and/or advanced therapy.	Ia, Ib, IIb, III
		4.4 Engage the team to ensure consistent implementation of the plan of care.	IIb, III, IV
5	**Evaluate Outcomes**	5.1 Determine if the outcomes have met the goals of care.	IIb, III
		5.2 Reassess patient, wound, environment and system if goals are partially met or unmet.	IIb, III, IV
		5.3 Ensure sustainability to support prevention and reduce risk of recurrence.	Ia, Ib, IIa, III, IV

accumulated from a variety of documents related to arterial disease. Levels of evidence are indicated in each recommendation.

In the previously published Wounds Canada BPR documents, the recommendations presented are supported by the levels of evidence described in the most current Registered Nurses' Association of Ontario (RNAO) best practice guidelines (see Table 2). The literature in this document is obtained from national and international sources (such as the American College of Cardiology [ACC] and the European Cardiovascular Society [ECS]) and their levels of evidence may be classified using different systems (Appendix A). These differing levels of evidence have been translated into equivalent RNAO levels. Guidelines and consensus documents cited in this best practice document are listed in Appendix B.

Table 2: RNAO Levels of Evidence[22]

Ia	▪ Evidence obtained from meta-analysis or systematic review of randomized controlled trials
Ib	▪ Evidence obtained from at least one randomized controlled trial
IIa	▪ Evidence obtained from at least one well-designed controlled study without rand omization
IIb	▪ Evidence obtained from at least one other type of well-designed quasi-experimental study
III	▪ Evidence obtained from well-designed non-experimental descriptive studies, such as comparative studies, correlation studies and case studies
IV	▪ Evidence obtained from expert committee reports or opinions and/or clinical expe riences of respected authorities

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Step 1: Assess and/or Reassess

Step 1: Assess and/or Reassess

As with all types of wounds, a comprehensive assessment is a priority when caring for a patient with or at risk for a lower extremity arterial ulcer. This assessment should include the patient's medical history and current health status, as well as an accurate history of any existing arterial wound. A head-to-toe physical examination, including a wound assessment, should be completed as soon as possible. The assessment process should be carried out with consideration of the patient's environment, care setting and socio-economic and cultural factors. The patient's access to health-related services and programs, as well as health-care policy specific to their geographical area, will all have an impact on the timeliness of investigations of an existing or potential arterial ulcer. Both national and international BPGs specific to wound care, vascular surgery and diabetes management recommend that an assessment of arterial blood supply be carried out before determining a treatment plan.[4,8–9,12,23–26]

Recommendations

1.1 Select and use validated patient assessment tools.

Currently, there is no available literature that reports on validated tools specifically designed to obtain measures on arterial ulcers. A literature review identified existing measurement tools useful in vascular assessment (see Table 3) and the assessment of a patient with PAD/LEAD (see Table 4). To review the specific validity, reliability, sensitivity and/or specificity of each measurement tool, please refer to the referenced papers.

In 2014, the Society for Vascular Surgery created a new risk stratification system called the WIfI classification, which was designed specifically to estimate amputation risk.[9,27] The WIfI classification system was developed for use during the initial patient assessment, targeting those who present with ischemic rest pain, diabetic foot ulcers, non-healing lower limb wounds and/or gangrene.[9,27] Similar to the Fontaine and Rutherford classification systems, the WIfI includes scores for varying degrees of ischemia and tissue loss; however, it also adds a score for the presence and severity of infection.[9,27] Although tissue perfusion is considered to be a primary determinant of patient outcomes, the presence and severity of infection can also increase the risk to the limb in regard to potential amputation.[27] Higher WIfI scores also conclude a diagnosis of CLTI, and increased risk of lower extremity amputation.[9]

Other existing instruments are available but require confirmed validation: Physical Examination and Chronic Lower-Extremity Ischemia, Intermittent Claudication Questionnaire (ICQ), San Diego Questionnaire, LEGS score based on TASC, Finnvasc and PAD nomogram.[27–32]

Table 3: Vascular Assessment Tools*

Tool	Description	Items
Fontaine Classification[33]	▪ Identifies clinical presentation of LEAD in 4 stages ▪ Based on clinical symptoms, without other diagnostic tests ▪ Originally German**	Stage I – Asymptomatic Stage Ia – Mild claudication Stage IIb – Moderate to severe claudication Stage III – Ischemic rest pain Stage IV – Ulceration or gangrene
Rose Questionnaire[34–35]	▪ Determines pain experience of patients with cardio-ischemic disease ▪ Standardizes identification of angina to exercise, pain due to myocardial infarction and intermittent claudication ▪ Moderate sensitivity and high specificity[36] ▪ Validated with 2000 subject to become WHO/Rose Questionnaire	Includes 8 questions: 1. Do you get a pain in either leg on walking? 2. Does pain begin when standing still or sitting? 3. Do you get this pain in your calf/calves? 4. Do you get it if you walk uphill or hurry? 5. Do you get it when you walk at an ordinary pace on the level? 6. Does it ever disappear while walking? 7. What do you do if you get it while walking? 8. What happens to the pain if you stand still?

Rutherford Classification[37–38]	▪ Classifies PAD into acute and CLTI
	▪ Provides definitions and criteria to standardize:
	  ▪ Severity of PAD
	  ▪ Therapeutic intervention
	  ▪ Outcomes
	▪ Approved by the Joint Council of the Society for Vascular Surgery and the North American Chapter of the International Society for Cardiovascular Surgery
	▪ Evidence based on other variables (concurrent, predictive and convergent validity) for each clinical symptom
		Grades/Categories:
		▪ Grade 0 Category 0: Asymptomatic
		▪ Grade I Category 1: Mild claudication
		▪ Grade I Category 2: Moderate claudication
		▪ Grade I Category 3: Severe claudication
		▪ Grade II Category 4: Ischemic rest pain
		▪ Grade III Category 5: Minor tissue loss, non-healing ulcer, focal gangrene with diffuse pedal ischemia
		▪ Grade III Category 6: Major tissue loss extending above trans metatarsal level, functional foot no longer salvageable

Edinburgh Claudication Questionnaire (ECQ)[39]	▪ Updated Rose Questionnaire with improved sensitivity while maintaining high specificity ▪ Also available in French ▪ Tested on 300 subjects > 55 years of age ▪ High sensitivity and specificity; high negative predictive and positive predictive value ▪ Excellent reproducibility after 6 months	Includes 6 elements: 1. Pain or discomfort in the legs with walking 2. Pain on sitting or standing 3. Pain going up stairs or hurrying 4. Regular walking pain 5. Pain duration of 10 minutes or more 6. Site of pain

cont'd.

Lower Extremity Threatened Limb Classification System: Risk Stratification Based on Wound, Ischemia and foot Infection (WIfI)[27]	▪ Evaluates:
	  ▪ Presence and extent of infection
	  ▪ Degree of ischemia
	  ▪ Tissue loss
	▪ Not meant to function as a stand-alone clinical decision-making tool
	▪ Validation currently in progress
		W: Wound/clinical: Society for Vascular Surgery (SVS) grades for rest pain and wounds/tissue loss (ulcers and gangrene): 0 (ischemic rest pain, ischemia grade 3; no ulcer), 1 (mild), 2 (moderate), 3 (severe)
		
		I: Ischemia hemodynamics/perfusion: Measure toe pressure (TP) or transcutaneous oxygen pressure ($TcPO_2$) if ankle-brachial pressure index (ABPI) incompressible (> 1.3) SVS grades 0 (none), 1 (mild), 2 (moderate) and 3 (severe)
		
		fI: Foot Infection: SVS grades 0 (none), 1 (mild), 2 (moderate), and 3 (severe: limb and/or life-threatening)
		
		SVS adaptation of Infectious Diseases Society of America's (IDSA) and International Working Group on the Diabetic Foot's perfusion, extent/size, depth/tissue loss, infection, sensation (PEDIS) classifications of diabetic foot infection

**The decision to employ one of the previously described measurement tools is most often based on personal preference of the specialist or vascular surgeon. There is no current literature or consensus that supports use of one over the other. Even though different vascular measurement tools have been described, they should be used cautiously, and they should never replace a thorough vascular assessment and clinical judgment.*

***Clinicians should be aware that measurement tools originally created in another language must have the comparability of translated and adapted scores evaluated to confirm both validity and reliability/precision[40–42]*

Literature review used with permission from Maryse Beaumier.

Table 4: Additional Assessment Tools*

Assessment Category	Tool	Purpose
Pain	Wong-Baker Faces Pain Rating Scale	Rates level of pain on a scale
Nutrition	Canadian Nutrition Screening Tool	Uses a two-question screen to predict adverse outcomes related to nutrition
Quality of Life	Cardiff Wound Impact Questionnaire	Measures impact of chronic wounds (leg ulcers and diabetic foot ulcers) on patient health-related quality of life (HRQoL), identifies areas of patient concern
Wound	Bates-Jensen Wound Assessment Tool (BWAT)	Evaluates all aspects of a wound (and periwound) with a 14-item tool using a scale from 1–5

**The decision to employ one of the previously described measurement tools is most often based on personal preference of the specialist.*

A more detailed discussion of validated tools to assess pain, quality of life, nutrition and wound status can be found in Best Practice Recommendations for the Prevention and Management of Wounds.

1.2 Identify risk and causative factors that may impact skin integrity and wound healing.

The overall health status of an individual has a significant impact on skin integrity, risk for ulceration and the trajectory of wound healing. Awareness and recognition of the presence of PAD/LEAD by primary health-care providers has a significant impact on the prevention of arterial ulcers and should be emphasized both in education and in clinical practice.[8] A national cross-sectional survey of PAD Awareness, Risk, and Treatment: New Resources for Survival (PARTNERS) program found that PAD afflicts 29% of patients who are ≥70 years of age, and 20–29% of those aged 50 to 69 years who report a 10-pack-per-year or more history of smoking.[9,43]

1.2.1 Patient: Physical, emotional and lifestyle

Physical Health and Vascular Status

Table 5 lists the major modifiable and non-modifiable risk factors believed to predispose a person with PAD/LEAD to the development of an arterial ulcer.[44–45] A crucial aspect of a patient's initial assessment is the identification of prevention and management strategies that can minimize the impact of these risk factors. Ongoing reassessment is the key to sustaining healing and optimizing patient outcomes.

Table 5: Modifiable and Non-modifiable Risk Factors

Modifiable	Non-modifiable
▪ Glycemic level: hyperglycemia results in delayed wound healing and compromised chemotaxis and phagocytosis[9] ▪ Smoking: increases the risk of wounds through compromised blood flow and delays healing. Smoking increases the risk of PAD 2- to 3-fold.[46] ▪ Comorbidities: diabetes,[46] dyslipidemia,[9,46] hypertension,[9,46] PAD and intermittent claudication,[46] renal failure[44–45] ▪ Abdominal obesity[46] ▪ Lack of physical exercise[9] ▪ Adverse health-related behaviours: excess alcohol and low fruit and vegetable consumption[44]	▪ Age: ≥65 years old[44–45] ▪ Age 50–64 years with risk factors for atherosclerosis (e.g., diabetes mellitus, history of smoking, hyperlipidemia, hypertension) or family history of PAD[47] ▪ Age <50 years, with diabetes mellitus and one additional risk factor for atherosclerosis ▪ Individuals with known atherosclerotic disease in another vascular bed (e.g., coronary, carotid, subclavian, renal, mesenteric artery stenosis or abdominal aortic aneurysm) ▪ Family history of PAD/LEAD[44–45]

Smoking and diabetes are the two primary risk factors pre-disposing an individual with PAD/LEAD to the development of an arterial ulcer.[9,27,48–49]

PAD/LEAD and Smoking

Smoking is a major risk factor for patients with PAD/LEAD, and it contributes to amputation risk, post-operative complications and death.[4,12,45–46,50–51] The relationship between smoking and PAD has been recognized since 1911, when Erb reported that intermittent claudication (IC) was three times more common among smokers than among non-smokers.[4] Heavy smokers have a four-fold increased risk of developing IC compared with non-smokers.[4] PAD is most often diagnosed one decade earlier in smokers than in non-smokers.[4]

Heavy smoking decreases tissue perfusion by causing peripheral vasoconstriction.[4] Smoking a cigarette decreases arterial blood supply by more than 30% in 45 minutes in specific areas of the body, especially in distal areas.[52]

A recent meta-analysis demonstrated that there is now substantial evidence of the association between active smoking and the progression of PAD/LEAD.[53] The risk for PAD/LEAD is reported as lower among ex-smokers but, nonetheless, significantly increased compared with those who have never smoked.

PAD/LEAD and Diabetes

Diabetes is the second most significant risk factor for developing LEAD and lower extremity ulcers. PAD frequently co-exists with peripheral neuropathy;[4,54] neuropathy impairs sensory function, often resulting in a lower extremity ulcer.[27,48–49,55] LEAD is more aggressive with DM, and frequently co-exists with peripheral neuropathy. Peripheral neuropathy impairs sensory function, often resulting in a progression of LEAD that goes undetected or is masked. Masked or undetected LEAD increases the risk for ulceration, infection and limb loss[23] According to a meta-analysis of patients with diabetes, every 1% increase of HbA1c corresponds to a 26% increased risk of PAD.[55] The 2004 Inlow 60-second Diabetic Foot Screening Tool is a predictive tool that has since been validated for interrater and intrarater reliability, as well as predictive validity, and can be used to assess for risk factors that increase an individual's risk for ulceration and amputation. In 2008 the International Working Group on the Diabetic Foot (IWGDF) developed a risk-classification system that correlates risk factors with complications such as ulceration and amputation. This tool enables health care professionals to assign a specific risk category (from 0–3) to individual patients. The updated Inlow tool has been augmented to include the IWGDF's classification tool so it can support the development of appropriate and timely care plans for individuals at risk of developing an ulcer.[56]

PAD/LEAD and Other Factors

Along with inquiring about smoking and DM, a family medical history is thought to be significant for determining other risk factors and should be obtained during the initial assessment.[8]

A comprehensive assessment that includes assessing the patient's physical, mental and emotional health and lifestyle enables the health-care team to formulate appropriate goals and sustainable treatment plans for the prevention and management of arterial ulcers. An assessment of arterial blood supply should be carried out before determining a treatment plan for a person with a lower extremity wound.[4,12,14,23–25] Blood flow status helps to determine the most appropriate goals of care such as wound healing, minimizing the risk of infection and preventing further injury. It is important that a clear diagnosis of LEAD be established, particularly when other comorbidities exist that may impact the integrity of the skin and tissues of the lower extremities. The presence of PAD is also a marker for systemic atherosclerosis, early death associated with cardiac and cerebrovascular disease, and is frequently associated with imminent limb loss.[57] PAD affects 20–29% of individuals over 70 years of age. Most patients do not develop gangrene or require amputations.[9,43]

Patients diagnosed with coronary artery disease (CAD) should be screened for PAD.[9] It is recommended that patients over 70 years of age and patients over 50 years of age with atherosclerosis risk factors be screened for a history of walking impairments, claudication, ischemic rest pain and the presence of non-healing wounds on the lower extremities.[58]

Medications

In addition to an overall review of a patient's over-the-counter and prescription medications, special attention should be paid to medications known to interfere with skin health or the healing of arterial ulcers, and these should be reviewed for continued dose-appropriateness or (temporary) discontinuation. Similarly, medications that would be indicated for routine management of LEAD, such as antiplatelet agents, should be assessed for their appropriateness in light of the patient's current health conditions.

Comorbidities

Conditions such as anemia and chronic obstructive lung disease that affect overall tissue perfusion should be taken into consideration. Increased surveillance is required when diabetic neuropathy, venous insufficiency, structural deformities and mobility issues coexist with an arterial ulcer. These common comorbidities can result in increased risk of injury, skin breakdown and infection when a patient is diagnosed with PAD.[12]

Variations in Presentation

PAD/LEAD

The clinical presentation of PAD/LEAD may vary significantly in different individuals. More than 50% of patients with PAD are asymptomatic, and the disease can remain undetected unless specifically screened for.[4] Others may experience significant intermittent claudication, atypical leg pain, rest/night pain, ischemic ulcers and gangrene.[19]

PAD/LEAD can be classified as symptomatic, asymptomatic or masked. Masked PAD/LEAD is a subgroup of asymptomatic PAD/LEAD that remains undetected as a result of the patient's physical inability to walk or the presence of any form of neuropathy that results in a decreased sensitivity to pain.[9] Both diabetic neuropathy and other neurological

conditions, such as spinal stenosis, can contribute to masked PAD.[9] Masked PAD, occurring more often in older patients, women and those with multiple comorbidities, should be distinguished from asymptomatic.[9] An assessment of walking capacity is recommended when possible to determine masked PAD.[9] The 2017 European Cardiovascular Society (ECS) best practice guidelines report that, "While all asymptomatic patients are at risk of CV events, the subgroup with masked PAD is also at high risk of limb events."[9] This explains why an asymptomatic patient can shift rapidly to severe PAD.[9]

Critical Limb Threatening Ischemia (CLTI)

PAD/LEAD may progress to CLTI,[8] a condition characterized by chronic ischemic rest pain presenting for >2 weeks, non-healing ulcers and/or gangrene in one or both lower extremities in conjunction with a clear diagnosis of PAD/LEAD.[4] The diagnosis of CLTI is based on a constellation of symptoms in lower-limb tissues that include loss of hair on the dorsum of the feet and toes; cool, shiny or dry skin; thickening of toenails; devitalized soft tissue with a dry or wet crust; atrophy of the skin; and mummified or dry black toe(s).[8] Another clinical sign, revealed by performing the Buerger's test, is when an elevation of the lower extremity results in pallor, but when the extremity returns to a dependent position the foot is ruborous (often called dependent rubor).[57,59] This rapid return of colour is called reactive hyperemia and is considered a sign of advanced PAD/LEAD.[59] Pain in advanced PAD/LEAD is localized in the toes or the distal foot and not in the calf when the patient is supine. Relief will occur upon sitting or standing.[4] Increased capillary refill time, as well as altered or absent pulses in the lower extremity may also be indicators of LEAD. However, capillary refill is not a reliable indicator of tissue perfusion;[60] therefore, a validated assessment tool should be used to provide an accurate measure of peripheral blood flow. The diagnosis of CLTI should be confirmed by diagnostic vascular studies (see Table 7).[4]

The incidence of CLTI varies from 500 to 1000 new cases per one million (European and North American populations) every year.[4] Multi-centre trials report that 40% of patients diagnosed with CLTI will have a leg amputation within six months; up to 20% of this population—those who are not candidates for revascularization or have experienced a failed revascularization attempt—will die.[4,61]

Thus, persons with CLTI should always be assessed for the level of risk for amputation.[9] A low ankle-brachial pressure index (ABPI < 0.9) is one of the strongest indicators of PAD/LEAD, cardiovascular (CV) risk and associated mortality.[9] Fontaine, Rutherford and WIfI are classification systems used by clinicians to grade the level of disease, thus the risk of an eventual amputation (see Tables 3 and 4). In addition to tissue ischemia, the presence of a wound and infection should be considered when determining amputation risk, as presented in the WIfI classification system.[9]

Acute Limb Ischemia

CLTI, associated with a progression of PAD/LEAD, should also be differentiated from acute limb ischemia (ALI).[4,62] The clinical presentation of ALI starts with abrupt onset of severe foot pain and the absence of peripheral pulses. Acute arterial occlusion may result from primary arterial thrombosis, arterial embolus or arterial dissection. The heart is the source of embolus in 85% of episodes.[63] Differentiating between thrombosis and embolic etiology can be difficult. However, a history of claudication points to thrombosis; atrial fibrillation points more to an embolic cause. The classical "six Ps" of ALI are strong indicators: pain, pallor, pulselessness, poikilothermia (cold), paresthesia and paresia (paralysis).[4] The presence of paresthesia and paresis favours the diagnosis of ALI, and they should not be present with CLTI. Sometimes patients with some form of symptomatic LEAD will present with acute ischemia; hence the importance of

the neurological evaluation of sensation and motor deficit. Assessment by a vascular specialist is recommended as soon as possible as this is considered to be a vascular emergency, especially in the interest of limb preservation.[9,58] The three main categories of ALI are viable, threatened and irreversible (see Table 6).

Table 6: Acute Limb Ischemia Classifications[64]

Category	Description
Viable	▪ Limb not immediately threatened; no sensory loss; no muscle weakness; audible arterial and venous Doppler
Threatened	▪ Mild to moderate sensory or motor loss; inaudible arterial Doppler; audible venous Doppler ▪ May be further divided into IIa (marginally threatened) or IIb (immediately threatened)
Irreversible	▪ Major tissue loss or permanent nerve damage inevitable; profound sensory loss, anesthetic; profound muscle weakness or paralysis (rigor); inaudible arterial and venous Doppler.

Physical Examination

Physical examination of a patient with LEAD can confirm the clinical impression and can help determine the severity and extent of the disease. The assessment should include a comprehensive examination of the pulses of the lower extremities, along with an inspection of both feet.[45,58] When a wound is present, the physical examination should focus on the evaluation of arterial blood flow to determine the degree of healability of the arterial wound site.[4,12]

The Importance of Palpation

Examination for vascular status must include palpation of all lower extremity pulses (i.e., femoral, popliteal, dorsalis pedis and posterior tibial), auscultation for abdominal and femoral bruits, and inspection of the legs and feet.[4,8,12,14,65] Arterial palpation can identify a decrease in the amplitude of the pulse pressure, revealing proximal obstruction to blood flow, and can help to identify the disease location. For example, finding a normal pulse in the femoral artery and no pulse in the popliteal artery space in a patient with calf claudication would point to a severe stenosis or occlusion of the superficial femoral artery. A decreased femoral pulse signifies aortoiliac disease.[47]

Bruit, a sound heard through a stethoscope placed over the artery, is produced by the turbulence of blood flow in a stenotic arterial segment. The presence of bruit may also be found in the abdomen, indicating aortic, iliac or renal artery stenosis. The lack of bruit, however, does not exclude disease. Any doubt of occlusion or alteration of blood supply should promote further investigations.

Diagnostic Studies

Currently, the diagnostic tests used to screen for and confirm PAD/LEAD include: ankle-brachial pressure index (ABPI), toe brachial pressure index (TBPI), duplex ultrasound (DUS), pulse volume recording (PVR), transcutaneous oxygen tension ($TcPO_2$), continuous-wave and leg segmental pressure measurements, computed tomography angiography (CTA), magnetic resonance angiography (MRA) and conventional angiography.[4,9,58] Some of these investigative methods can also provide valuable information regarding the location, characteristics and severity of occlusive lesions in arterial vessels as a result of LEAD (see Table 7).

Table 7: Diagnositc Tests for Investigating PAD/ LEAD

Diagnostic Test	Indications	Contraindications and Limitations	Benefits
Ankle-Brachial Pressure Index (ABPI)	▪ First-line test for the screening and diagnosis of PAD/ LEAD[9,58,66] ▪ May be the only test required to help establish a diagnosis of disease[4,45,50] ▪ Useful to screen for asymptomatic PAD so that appropriate cardiovascular(CV) prevention strategies can be initiated.[58] ▪ Useful for surveillance of lower extremity arterial disease after revascularization[9]	▪ Primary limitation is the presence of non-compressible vessels (calcification of the distal arteries in the lower extremities as a result of diabetes),[4,67-68] which may be indicated by an ABPI measure > 1.40[9] ▪ Requires appropriate diagnostic equipment to be available[9] ▪ A trained sonographer is recommended/preferred[9] ▪ Use of automated blood pressure (BP) cuffs is **not** recommended[9] ▪ Sensitivity is lower in the elderly and individuals with diabetes[68]	▪ Non-invasive ▪ Inexpensive ▪ Can be performed resting or with treadmill exercise ▪ A strong marker for the presence of CV risk and generalized atherosclerosis[9] ▪ A 2–3-fold increase in CV-related death is associated with an ABPI < 0.90[9] ▪ Preliminary diagnosis can be made with measures obtained manually with a well-trained clinician,[9] but should be interpreted with caution and in the context of a full clinical picture.[60]
Ankle-Brachial Pressure Index (ABPI) with treadmill exercise	▪ Useful to repeat testing if a normal ABPI measure is obtained with existing IC[9] ▪ Performed to rule out asymptomatic or masked PAD [9,58] ▪ Useful in differentiating arterial claudication from non-arterial claudication (pseudo claudication) comparing pre- and post-test measures.[58] ▪ Useful to detect a proximal lesion on the aorta or iliac artery that contributes to a normal resting ABPI measurement[58]	▪ Requires access to a treadmill in addition to other routine equipment ▪ Physical/functional limitations may be a barrier	▪ Better screening for individuals with ABPI measures of 0.91 to 1.30, not exhibiting symptoms of IC, who could be at risk for PAD.[8] ▪ Useful in assessing functional limitations associated with PAD, and to determine safe parameters for an exercise program[58]
Toe-Brachial Pressure Index (TBPI)	▪ Used when non-compressible vessels exist (calcification of vessels resulting from diabetes)[9] ▪ Used to diagnose patients with suspected PAD/LEAD when ABPI > 1.40[9,45,62,69-71] ▪ Used with normal or borderline ABPI measures when there is the presence of non-healing wounds or gangrene[9,72-73] ▪ Used to diagnose CLTI[45,74-78]	▪ Requires appropriate diagnostic equipment to be available[9] ▪ A trained sonographer is recommended[9]	▪ Non-invasive ▪ Inexpensive ▪ Useful to support the prescribing of compression for cases when significant edema and/or non-compressible vessels hinder reliable ABPI measures ▪ Sensitivity and specificity are better than ABPI for diabetic patients[4,16,68]

cont'd.

Computed Tomography Angiography (CTA)	▪ Can determine the location, characteristics and severity of occlusive lesions in the lower extremities[58] ▪ Generally reserved as part of the investigative process when revascularization is being considered[58] ▪ Used for patients warranting invasive intervention such as percutaneous transluminal angioplasty (PTA) or vascular surgery	▪ Requires the administration of nephrotoxic, iodinated contrast medium[9,58] ▪ Patients with renal failure, diabetes or dehydration are at risk for contrast-induced renal failure, so caution is warranted[9,58] ▪ Image quality may be obscured by the presence of arterial calcification or metallic implants[9] ▪ Past or suspected sensitivities to contrast medium should be investigated, along with a review of renal function, prior to test[58]	▪ Can produce a high resolution, 3-D visualization of cross sections of vessel lumens, allowing for an accurate determination of vessel diameter and stenosis severity[9] ▪ Can be used with end-stage renal patients on dialysis[9] ▪ Recommended for optimizing revascularization strategy[58]

Ankle-Brachial Pressure Index (ABPI)

For a detailed description of ABPI and instructions for performing this test, see How-to Conduct an ABPI.[79] For an in-depth discussion of the science underlying the ABPI test, and information about when to use this test, see The Science Behind ABPI.[80] Healthcare professionals should keep in mind that LEAD may affect each of the three primary arterial vessels of the lower extremity in varying degrees. Recent studies show the importance of calculating the ABPI using measures taken from two arteries of each foot.[26] The arterial flow in the foot can be divided into six individual regions called angiosomes.[81] Therefore, recent literature provides some evidence that the specific location of a foot ulcer should be taken into consideration and may provide guidance for vascular an plastic surgery decision. [26] See Table 8 for interpretation of blood flow and perfusion measures.

Table 8: Assessing Arterial Flow and Perfusion

Grade	Ankle-Brachial Pressure Index	Toe Brachial Index	Toe Pressure	Waveforms	Transcutaneous Oxygen Pressure (indicating perfusion)
Non-compressible	> 1.40 Be aware of possible **falsely** elevated measures	Preferred when vessels are non-compressible	Preferred when vessels are non-compressible		Preferred when vessels are non-compressible
Normal Range	1.0–1.40	> 0.7	> 70 mmHg	Triphasic	> 40 mmHg
Borderline	0.91–0.99	> 0.6	> 70 mmHg	Biphasic/monophasic	> 40 mmHg
Abnormal	< 0.90	< 0.6	< 70 mmHg	Biphasic/monophasic	< 40 mmHg
Mild	0.7–0.9	> 0.4	> 50 mmHg	Biphasic/monophasic	30–39 mmHg
Moderate	0.41–0.69	> 0.2	> 30 mmHg	Biphasic/monophasic	20–29 mmHg
Severe	< 0.4 critical limb ischemia (CLI/CLTI)	< 0.2	< 30 mmHg	Monophasic	< 20 mmHg

Figures 2, 3, 4: Systolic Pressure Measurements for Brachial, Posterior and Posterior Tibial Arteries for Calculating ABPI

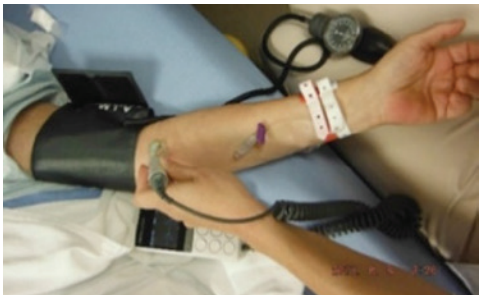


Figure 2: Brachial artery

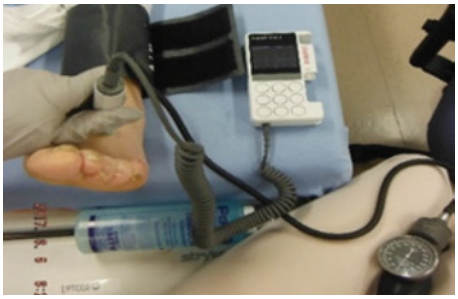


Figure 3: Left dorsalis pedis artery

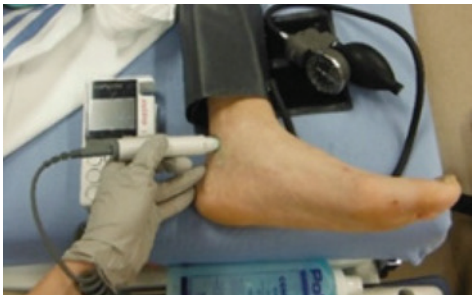


Figure 4: Left posterior tibial artery

Used with permission from Maryse Beaumier.

Toe-Brachial Pressure Index (TBPI)

A TBPI measure can be obtained similarly to an ABPI. A small, toe-sized cuff is applied, usually to the great toe, instead of the ankle. The availability of the toe cuff is essential. In the case of incompressible arteries, often the result of vessel calcification secondary to DM, a TBPI is a suitable, non-invasive examination that provides an objective indication of distal lower limb vascularization.[72-73,82] According to the 2016 American Heart Association (ASA)/American College of Cardiology (ACC) Guideline on the Management of Patients with Lower Extremity Peripheral Artery Disease,[82] when there is possibility of falsely elevated ABPI scores, TBPI with waveforms, along with other appropriate vascular examinations, such as PVR or $TcPO_2$, should be employed to ensure more accurate measures of arterial blood flow.[4,58,67,83] Arteries in the first digit are narrower and therefore less prone to the calcification that may result in false-positive (falsely elevated) measures.[72-73] Current guidelines for PAD/LEAD screening recommend the use of toe pressure with a threshold value < 0.70 mmHg to indicate the presence of PAD/LEAD.[4,16]

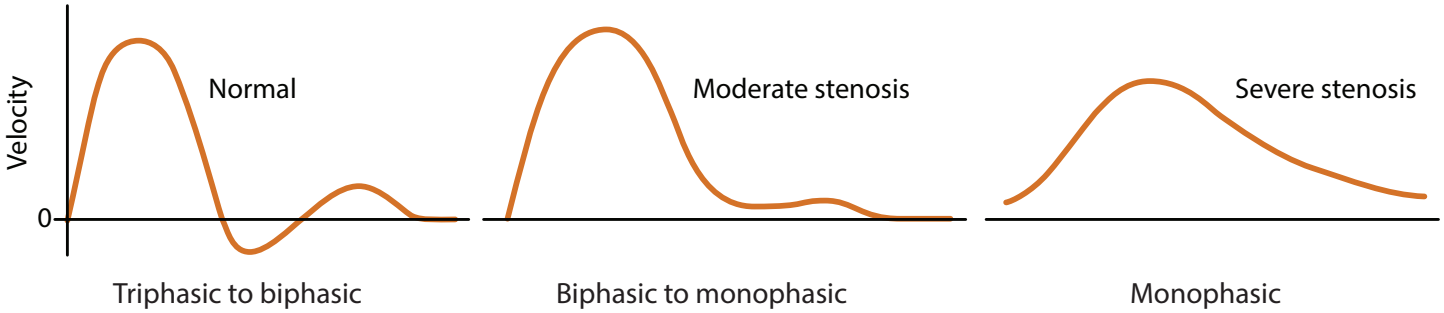
Pulse Volume Recording (PVR)

A PVR measure can be obtained using blood pressure cuffs and a hand-held ultrasound device (called a Doppler or transducer). Although PVR does not examine specific blood vessels, it does measure the volume change in the extremity at each heartbeat. It is not influenced by vessel calcification and it complements other non-invasive tests.

Doppler Waveforms

Doppler waveform measures are obtained using a hand-held Doppler, which is a relatively inexpensive and common piece of equipment used in cardiovascular departments and clinics. Using a probe of 5 to 8 MHz, waveforms can be classified as monophasic, biphasic or triphasic.[9] An audible hand-held Doppler reading of the dorsalis pedis or posterior tibial artery that is triphasic/biphasic is considered to be normal and equivalent to an ABPI >0.9.[84] A biphasic tracing is considered to be abnormal if the clinician can detect a clear transition from a triphasic signal along the vascular root.[84] In cases of severe LEAD, vascular resistance is lost in the blood vessel and a monophasic tracing can be recorded or heard. Waveforms that are monophasic should always be interpreted as abnormal and are a strong indicator of advanced occlusive disease (see Figure 5).[84]

Figure 5: Waveforms[85]



Obtaining a Transcutaneous Oxygen Tension ($TcPO_2$) Measure

$TcPO_2$ measures are obtained through the use of a transcutaneous oximetry device. The diagnostic test provides information about the supply and delivery of oxygen to the underlying microvascular circulatory system by recording the partial pressure of oxygen at the skin surface.[86] A $TcPO_2$ value of <40 mmHg (at normobaric air) suggests hypoxia sufficient to impair or prevent wound healing (in patients with and without diabetes).[87] Suggested thresholds for arterial wound healing range from 25 to 40 mmHg.[4,87–89]

Obtaining Continuous-wave and Leg Segmental Pressure Measurements

Obtaining leg segmental pressure measurements involves a more in-depth process and the availability of appropriate equipment. This diagnostic test requires considerably more time to prepare the patient than a traditional ABPI because it involves the application of inflatable cuffs at multiple levels. Mobility issues and obesity can be hindrances to performing this diagnostic test.

CTA and MRA

Computed tomographic angiography (CTA), magnetic resonance angiography (MRA) and contrast angiography are other diagnostic methods used to determine the location and severity of occlusive lesions in the lower extremities when LEAD exists.

CTA examines cross sections of the vessel lumen, allowing for visualization of structures such as vessel diameter and stenosis severity, as well as any existing lesions. The image quality may be obscured by the presence of arterial calcification or metallic implants. CTA is often used to intervene in the arteries with balloons and stents. Patients should be screened with appropriate blood work for renal insufficiencies before

the CTA is performed.[9] It is generally recommended that patients who have end-stage renal failure have the CTA performed prior to their scheduled dialysis.[9]

MRA is generally reserved for cases where more invasive interventions are being considered to correct the underlying LEAD and to optimize revascularization strategy.[9] Magnetic resonance angiography (MRA) does not show calcifications but gives better visualization of tibial vessels than CTA.

Conventional Angiography for Diagnostic Purposes

Conventional angiography, a more invasive approach to investigation, provides a comprehensive look at the arterial anatomy through the introduction of a contrast medium (dye) into the arterial system. Contrast angiography is reserved as part of the investigative process for when a patient with PAD is being considered for revascularization.[58] Contrast angiography is used for patients warranting invasive intervention such as percutaneous transluminal angioplasty (PTA) or vascular surgery. Clinicians should be wary of complications related to technique (puncture site hematoma, false aneurysm).

Pain Assessment

Managing pain is a priority for patients with LEAD who are experiencing IC, rest pain and/or local wound pain. Therefore, a patient's pain experience should be thoroughly assessed as an essential aspect of the plan of care. Pain assessment requires the use of validated measurement tools, such as the FACES, visual analogue and numerical rating scales.[24] The experience of pain is just one aspect of the differential diagnosis of PAD/LEAD and should be distinguished from other expression of pain related to other pathologies, such as venous disease and muscular or other neurological conditions.[45–46] Factors other than ischemic pain and IC may be contributing to the patient's overall pain experience and must be carefully considered and differentiated. For individuals who are likely experiencing IC, the six-minute walk test closely correlates to real-life outdoor walking capacity and quality of life.[90] The distance that the patient can walk in a six-minute period is recorded. As the symptoms of IC decrease, the distance that the patient can walk over the six minutes should increase. Another useful measurement tool is graduated maximal treadmill testing, which records the onset of IC during peak walking times.

Phantom limb pain (PLP) affects up to 90% of amputees.[91] This type of pain feels like it's coming from a body part that is no longer there, often as a result of surgical amputation secondary to LEAD. In the past it was often thought that this common post-amputation phenomenon was primarily psychological in nature; however, pain experts now recognize that these real sensations originate in the spinal cord and brain. A characteristic of PLP includes onset within the first few days of amputation, which often affects the part of the limb farthest from the body, such as an amputated foot or leg. PLP may come and go and is often described as shooting, stabbing, boring, squeezing, throbbing or burning. PLP may be triggered by pressure on the remaining part of the limb or emotional stress. Finding an effective way to manage PLP can be challenging.[92]

Feet and Footwear Assessment

A thorough assessment of the general condition of the skin and nails of the lower extremities can provide valuable insight into the overall risk level of the patient, particularity when altered skin integrity already exists. Clinicians should look for cool, shiny,

dry skin; colour changes (pale, bluish or dark reddish); loss of hair on feet and legs; thickening and brittleness of the toenails; open sores; skin infections or ulcers that will not heal.

It is also important to carry out an assessment of the patient's ability to perform self-care.

The type and fit of footwear or other orthopedic devices may be a potential source of external pressure and contribute to tissue damage.[58] Clinicians should also assess the ability of the patient to purchase and wear appropriate footwear and receive regular foot care.[4]

Pressure

Patients with LEAD are at high risk for skin breakdown as a result of poor tissue perfusion. Because of this, pressure over boney prominences on the lower extremities places them at risk for pressure injury and trauma from external forces (see Figure 6). The presence of peripheral neuropathy, with associated loss of protective sensation and/or foot deformity, may further increase the risk for pressure injury.[4,23,54] If there is significant arterial insufficiency, injuries may be unable to heal, potentially leading to infection, CLTI and amputation. Therefore, it is recommended that a person with LEAD be assessed for level of risk for pressure injury.[62] The Braden Scale for Predicting Pressure Ulcer Risk is one example of a commonly used validated assessment tool for predicting the risk of pressure injury.[93] A 2015 review Pressure Ulcer Programme of Research (PURPOSE) specified three primary risk factor domains relative to pressure injury risk. These domains were identified as mobility/activity, skin/pressure injury status and tissue perfusion. [94-95]

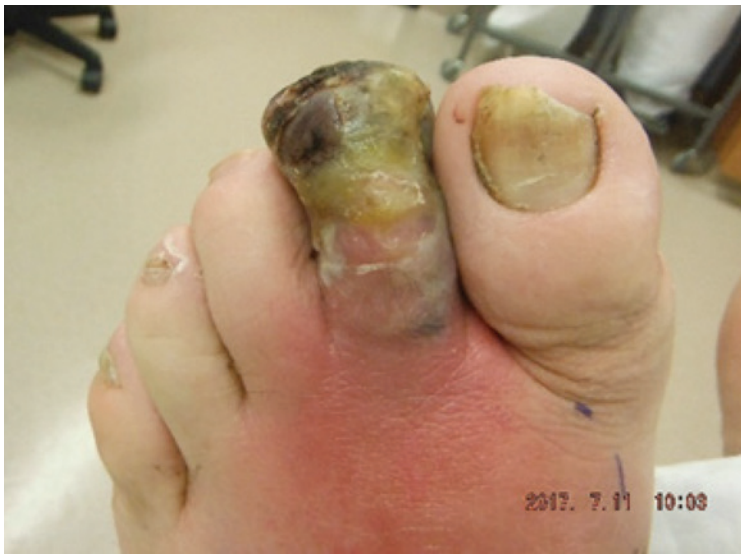


Figure 6: 63-year-old man, diabetes for 20 years, non-smoker. Ischemic wound created by pressure from work boot; deep tissue infection in progress

Used with permission from Maryse Beaumier

Activities of Daily Living

Inquiring about the activities of daily living (ADLs), including occupational and leisure tasks, provides an indication of a person's overall physical ability and may help to identify potential risk for skin injury. The degree to which a person can participate in everyday activities can impact considerably on their overall sense of health-relat-

ed quality of life (HRQoL). There are several quality-of-life questionnaires available to assess HRQoL, including the Medical Outcomes Study Short-Form 36 General Health Survey.[96–97]

1.2.2 Environmental: Socio-economic, care setting, potential for self-management

The socio-economic status of a patient may significantly impact their ability to participate in a treatment plan that has been designed to optimize their sense of wellness and prevent and manage arterial ulcers. A patient's access to basic daily need items and services, their support systems, and their educational level should be considered when determining their capacity for self-care and their ability to participate in a plan of care. Financial concerns may restrict the person's ability to take time off from work for medical appointments and to purchase dressing supplies or prescribed medical devices and medications. Poor psychosocial status may be associated with psychiatric illness, living alone, alcohol or substance use, poor hygiene or malnutrition. All of these factors have been found to be associated with an increased risk of developing an arterial ulcer and should be assessed.[4,8] Current guidelines also recommend that patients with PAD/LEAD be assessed for symptoms of clinical depression.[62]

1.2.3 Systems: Health-care support and communication

PAD/LEAD is a lifelong medical condition, often requiring surgical intervention.[9,46] Patients expected of having PAD/LEAD, in conjunction with the presence of a lower extremity ulcer, should be promptly referred to a vascular specialist.[8] Patients with PAD/LEAD have shortened life expectancies because of severe atherosclerotic disease. The five-year survival rate in non-diabetic patients with significant PAD/LEAD is 70%. Patients with both LEAD and renal failure have a two-year survival rate of <50%.[4] Ensuring that the appropriate professional, community-based support services and resources are accessible may be critical to the overall success of a plan of care designed to prevent and manage vascular disease.[98]

1.3 Complete a wound assessment.

Because arterial ulcers can be the result of multiple disease processes occurring simultaneously, clinicians should evaluate the patient as a whole, identifying all of the underlying and potential external causes (such as trauma) of the tissue damage.[12] An essential aspect of the assessment of an arterial ulcer is the etiology of the wound.[60] It is recommended that wound assessment and local wound care begin with identifying the etiology of the ulcer and minimizing or correcting any other co-factors or conditions that exist.[69-75,99-100]

The assessment of an arterial ulcer should include the location, shape, size, tissue type, presence and nature of wound exudate, presence of malodour, periwound tissue characteristics and wound pain.[62]

Validated assessment tools should be used to measure and describe the characteristics of the local wound environment and surrounding tissues and to determine whether wound healing is taking place.

Characteristics of an arterial (ischemic) ulcer include the following:

- Often on the lower extremities; less frequently on the upper extremities but can occur
- "Punched out" appearance with well-defined borders (see example, Figure 7)

- Often associated with little or no exudate or periwound edema
- Often deep, with possible exposure to tendon and/or bone
- Often has yellow slough or black eschar, with minimal or no granulation
- Often associated with moderate to severe pain (see example, Figure 8)
- Ischemic regions may appear as dry gangrene (see example, Figure 9)
- Periwound tissues may be pale, shiny, dry, with loss of hair and dystrophic nails
- Often appear over boney prominences or other areas being traumatized by external pressures (see example, Figure 9)

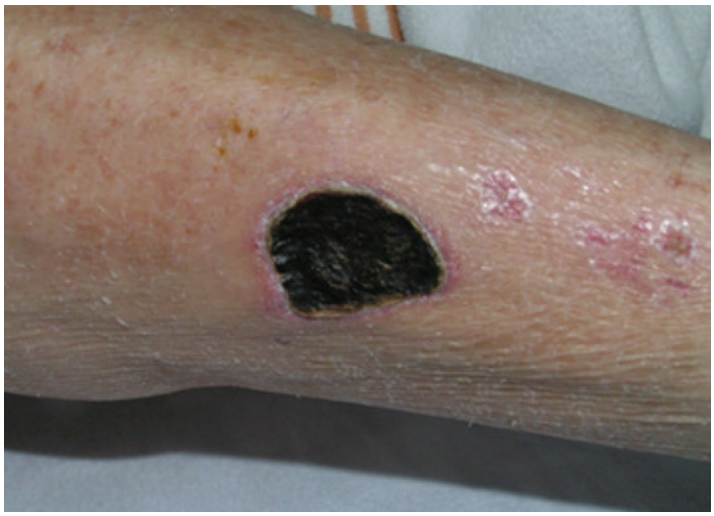


Figure 7: Large, dry arterial ulcer (eschar) on the leg of a male, heavy smoker, non-diabetic

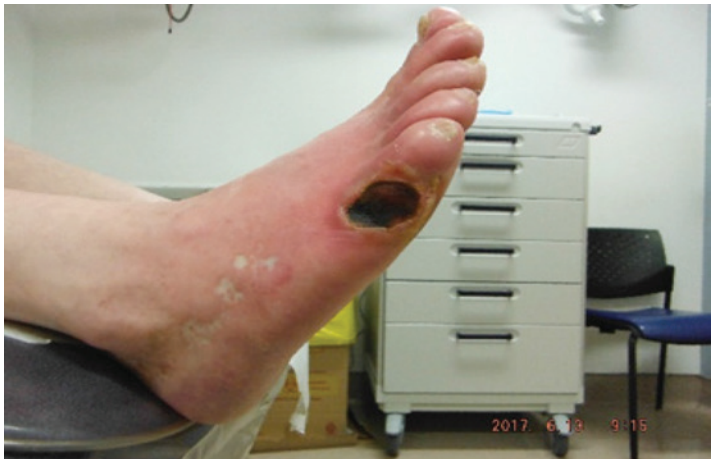


Figure 8: 51-year-old female with diabetes, heavy smoker, ischemic pain, TBPI: 20 mmHg

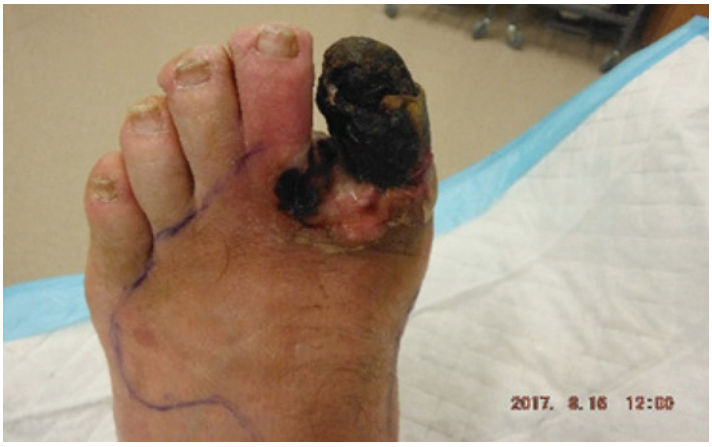


Figure 9: 57-year-old male with type 2 diabetes with sensitive neuropathy, waiting for revascularization

Figures 7–9 used with permission from Maryse Beaumier.

After completing a thorough assessment of the local wound site, clinicians should determine the risk of complications, including infection and amputation.

Assessment for Risk of Infection

Wound infection is the most common complication of non-healing wounds.[101] Poor arterial blood supply to a wound site, along with the effects of other comorbidities that impact overall tissue perfusion, will contribute to poor resistance to wound infection[11] Vigilant monitoring of arterial ulcers during the healing process is recommended because inadequate blood flow can suppress signs and symptoms of wound infection and impede the body's ability to fight the infecting pathogens.[102] A diagnosis of clinical wound infection should be determined only after careful consideration of several factors. Assessment should begin with a comprehensive physical exam, followed by a careful assessment of the wound site.

A clinical diagnosis of wound infection is sometimes made based upon clinical signs, patient-reported symptoms and good clinical judgement. However, a more definitive diagnosis of infection can be made with the support of microbiology testing (culture and sensitivity) and blood specimens. Although antimicrobials are sometimes prescribed based on a clinical diagnosis, culture-specific-directed care is the preferred approach because it can identify specific pathogens that may be causing the infection along with sensitivity guidelines for prescribing specific antimicrobials. Poor blood flow may suppress inflammatory signs of infection,[76] including erythema, heat and induration.[77] Therefore, a high degree of suspicion may be warranted for PAD/LEAD-related wounds. As well, the presence of high levels of exudate and macerated periwound skin should raise suspicion for infection in arterial wounds.[103]

For detailed information on how to manage PAD-related wound infections, clinicians are referred to the current IDSA guidelines.[77]

Tips for Obtaining Wound Culture Specimens

For tips on completing a wound culture specimen, refer to Wounds Canada's Best Practice Recommendations for the Prevention and Management of Wounds.[21]

Step 2: Set Goals

Step 2: Set Goals

Recommendations

2.1 Set goals for prevention, healing, non-healing and non-healable wounds.

Following a comprehensive assessment of the patient, their wound, and environment and systems factors, goals for prevention and management can be determined in a collaborative process carried out between the health-care team, the patient and their care partners. Patient-driven goals should be developed based on SMART (specific, measurable, attainable, relevant, timely) principles.[33]

Health-care professionals need to consider the patient's goals, such as: Is the patient's primary goal to close the ulcer? Is it to manage pain? Is it to be able to walk as far as the bathroom? An important aspect of the early stages of treatment is establishing realistic, achievable goals that are mutually understood and agreed upon by the clinicians and the patient.

2.1.1 Identify goals based on prevention or healability.

Arterial wounds fall into several healability categories that can guide realistic goal setting.[4,12,16,98,104-105] The prevention and healablility of arterial wounds is based on tissue perfusion. Clinicians can use the level of perfusion to help guide realistic goal setting (see Table 8).

Adequate perfusion indicates that there is sufficient blood flow to the limb to support tissue viability and wound healing.

2.1.2 Identify quality-of-life and symptom-control goals.

Generally, the primary goals in the treatment of CLTI are usually to alleviate pain, prevent amputation and improve the HRQoL of the patient, including the healing of any existing arterial ulcers (see Table 9). Patients will often prioritize symptom management, such as alleviating pain, when determining treatment goals. However, health-care professionals should encourage patients to identify HRQoL priorities as well. A decrease in overall sense of wellbeing and HRQoL is often associated with the experience of IC, rest/night pain and decreased mobility.[106-108] In patients with pure arterial ulcers, some of the pain may be associated with the ulcer; however, most pain is associated with ischemia. Pain associated with the arterial wound, IC and/or ischemia may contribute to patients becoming sedentary.[19]

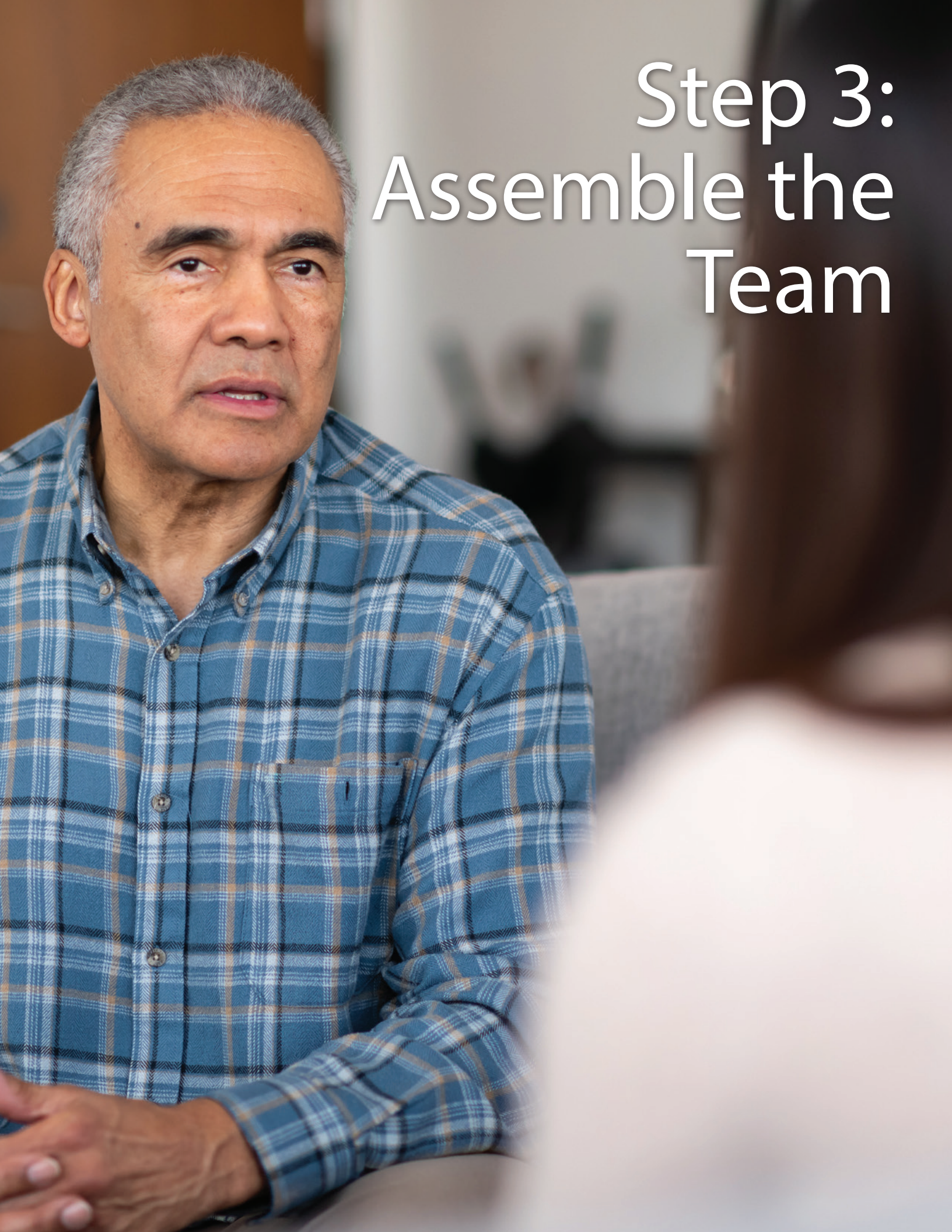
Table 8: Patient Goal Setting Based on Perfusion

PAD/LEAD Status	Perfusion	Examples of SMART Goals
Borderline*	Adequate	▪ Wound closure within 3 months following revascularization ▪ Satisfaction with local wound care with every dressing change[4,12,21,60,78,98,102] ▪ Appointment with a vascular specialist as soon as possible[9,46,58] ▪ Prevention strategies implemented in relation to wound infection, new trauma and pressure injury[45–46,58,60,62,76,102]
Post revascularization	Adequate	▪ Wound closure within 3 months following revascularization ▪ Appointment with a vascular specialist in accordance with surveillance protocols; potential re-stenosis monitored as per protocol[9,46] ▪ Prevention strategies implemented in relation to wound infection, new trauma and pressure injury[58,60,62,76,102]
Post revascularization (re-stenosis)	Inadequate	▪ Vascular appointment for reassessment (surveillance) and pending revascularization[9,46] ▪ Prevention strategies implemented in relation to wound infection, new trauma and pressure injury[58,60,62,76,102] ▪ Satisfaction with local wound care with every dressing change[9,12,21,60,86,97,103]
Pending revascularization	Inadequate	▪ Timely and successful revascularization to optimize blood flow[9,46] ▪ Prevention strategies implemented in relation to wound infection, new trauma and pressure injury[9,46,60,62,78,102] ▪ Satisfaction with local wound care with every dressing change[9,12,21,60,86,97,103] ▪ Ischemic pain controlled in conjunction with primary health-care provider[45–46,50,58,109-110]
Not a candidate for revascularization	Inadequate	▪ Wound care appropriate for a non-healing wound initiated immediately[9,46] ▪ Prevention strategies implemented in relation to wound infection, new trauma and pressure injury[9,58,60,62,76,102] ▪ Satisfaction with local wound care with every dressing change[9,12,21,60,86,97,103] ▪ Optimization of management of ischemic pain in conjunction with primar-health-care provider[45–46,50,58,109-110]
Undetermined		▪ Timely vascular assessment[9,46,58] ▪ Satisfaction with local wound care with every dressing change[9,12,21,60,62,86,103] ▪ Prevention strategies implemented in relation to wound infection, new trauma and pressure injury[9,58,60,62,76,102] ▪ Ischemic pain controlled in conjunction with primary health-care provider[9,45,50,60,109-110]

** Borderline here would refer to patient with just enough blood flow for healing; this assessment is difficult to make and should be part of the expert opinion regarding adequate perfusion to heal even though circulation may not be within optimal ranges.*

Table 9: Health-related Quality of Life and Symptom-control Goals[46,111]

Patient Concern	Examples of SMART Goals
Comorbid conditions	▪ A low-density lipoprotein (LDL-C) target of < 1.8 mmol/L (70 mg/dL) or less within 6 months, or decrease by ≥ 50% of baseline measures are 1.8–3.5 mmol/L (70–135 mg/dL)[9] ▪ Optimal blood pressure control: < 130/80 mmHg for persons with diabetes within 3 months ▪ HbA1c ≤ 7.0% (unless contraindicated as per specialist's recommendation) within 6 months ▪ Self-management of glucose control following education and teaching with diabetes specialist/dietitian ▪ Smoking cessation within 6 months with support of primary health-care provider or risk-reduction team
Rest and walking pain	▪ Pain decreased to 1/10–2/10 at rest within 1–2 weeks ▪ Taking anticoagulant medication as prescribed within 1–2 weeks ▪ Taking statin as prescribed within 1–2 weeks to improve walking distance ▪ Keeping legs in a dependent position (below heart level) as much as possible
Activities of daily living	▪ Walking 10–15 minutes longer before experiencing IC symptoms within 3–6 months of initiating a tailored exercise program ▪ Participating in supervised exercise at a level recommended by a health-care professional within 3 months ▪ Maintaining a healthy diet to support glucose control, appropriate body mass index (BMI) and healthy skin within 3–4 months
Emotional, cognitive, behavioural and mental health factors	▪ Participating in a smoking cessation program to reduce cigarette consumption to less than one pack a week within 3 months ▪ Engaging in self-care activities and adherence to plan of care aimed at prevention and management of ulceration and amputation within 1–2 months.
Infection prevention	▪ Participating in activities to maintain healthy feet, including not walking in bare feet, daily foot inspections and skin care immediately after assessment with a multidisciplinary team or foot specialist ▪ Regular podiatric care every 4–6 weeks ▪ Footwear fitted by a qualified health-care professional immediately following the closure of a foot ulcer ▪ Follow-up with primary care provider at first sign of ulceration or foot infection ▪ Awareness of signs and symptoms of infection and complications and changes that may be affecting blood flow to the lower extremities. ▪ Footwear fitted by a qualified health-care professional immediately following the closure of a foot ulcer ▪ Keeping feet clean and dry; no soaking



Step 3: Assemble the Team

Step 3: Assemble the Team

Discussion: Preventing and managing arterial ulcers requires the input of many health-care professionals and service providers. The patient and their care partners are essential members of the integrated team.[8]

Recommendations

3.1 Identify appropriate health-care professionals and service providers.

Patients with or at risk for arterial ulcers have specific concerns and risks that require a team of health-care professionals and supportive services that can work collaboratively with each other, the patients and their care partners. These team members might include a family physician, vascular surgeon or specialist, orthopedic surgeon, plastic surgeon, internal medicine specialist, risk reduction and modification specialist, infectious disease specialist, nurses (including CNS, NP, NSWOCC and wound specialist nurse), physical therapist and/or occupational therapist, diabetes educator, pharmacist, dietitian, pedorthist, orthotist, prosthetist, podiatrist or chiropodist, pain management specialist, psychologist, social worker, spiritual leader. See Table 10 for a description of the role each team member plays.

Table 10: Potential Professional Members of the Integrated Team

Team Member	Indication for Referral
Vascular surgeon or specialist	▪ Manage symptoms and reduce risk of ulceration, infection, CLTI and amputation in patients diagnosed with or suspected of having arterial insufficiency[9,58]
Orthopedic surgeon	▪ Support complex surgical interventions (amputation, remodeling/reconstruction) when extensive tissue loss results from LEAD
Plastic surgeon	▪ Consulted when surgical skin flaps and grafts are required post amputation or there is significant debridement of revascularized tissue
Internal medicine specialist and risk-reduction and modification specialists	▪ Consulted regarding the assessment and optimization of systemic comorbidities such as smoking status, lipid lowering, blood glucose and hypertension[58]
Infectious disease specialist	▪ Chronic infection secondary to LEAD may result in acute cellulitis, gangrene, and chronic and acute osteomyelitis. Timely consultation with a specialist who has expertise in empirical and culture-specific antimicrobial treatment can support the healing of arterial ulcers.[62]
Nurse with specialized wound education	▪ Provide specific clinical and educational support pertinent to the co-ordination of complex plans of care when multidisciplinary efforts are required
Physical therapist (PT) and/or occupational therapist (OT)	▪ Conservative treatment strategies may include exercise programs aimed at improving symptoms of intermittent claudication[46] ▪ Reconditioning and training programs are often required following a surgical amputation associated with LEAD, especially when prosthetics have been prescribed.

cont'd.

Diabetes educator, pharmacist, dietitian	▪ Assist in identifying and optimizing co-factors such as smoking, hypertension, glycemic control and obesity[62] ▪ Assist in appropriate calculations for renal dosing ▪ Assist in identifying and managing drug-drug and drug-disease interactions
Pedorthist, orthotist or prosthetist	▪ Manage intrinsic pressure associated with existing foot deformities or extrinsic pressure associated with inappropriate footwear or other mechanical devices[62] ▪ In cases where the amputation of a foot or lower limb has occurred, the patient may be a candidate for a prosthetic to aid in ambulation and/or transfers. Risk of falls and other mobility-related injuries should always be taken into consideration. Collaboration with an OT is sometimes beneficial.
Podiatrist, chiropodist	▪ Involved in foot care and regular foot inspection;[58] treatment of infection in collaboration with infectious disease specialist; prescription of offloading modalities considering biomechanics of the foot areas at risk of ulceration; prophylactic surgical offloading correction in carefully selected patients in collaboration with vascular surgeon
Pain management specialist	▪ The level of pain associated with ischemia often requires narcotics and a combination of analgesics and pain management strategies.[62]
Psychologist, social worker, spiritual leader	▪ Hospital-based and community-based supports to help patients navigate financial, social and relationship concerns
Family physician or other primary care provider (e.g., nurse practitioner)	▪ Participates in decisions concerning choices in pain management and referrals to other specialists for the management of comorbidities, and the ongoing management of this chronic disease.

It is common for individuals with LEAD to be receiving concurrent treatment for other comorbidities. Professional team members need to possess the expertise to manage a variety of co-factors, as well as modify the risk factors that will impact the patient's overall condition.

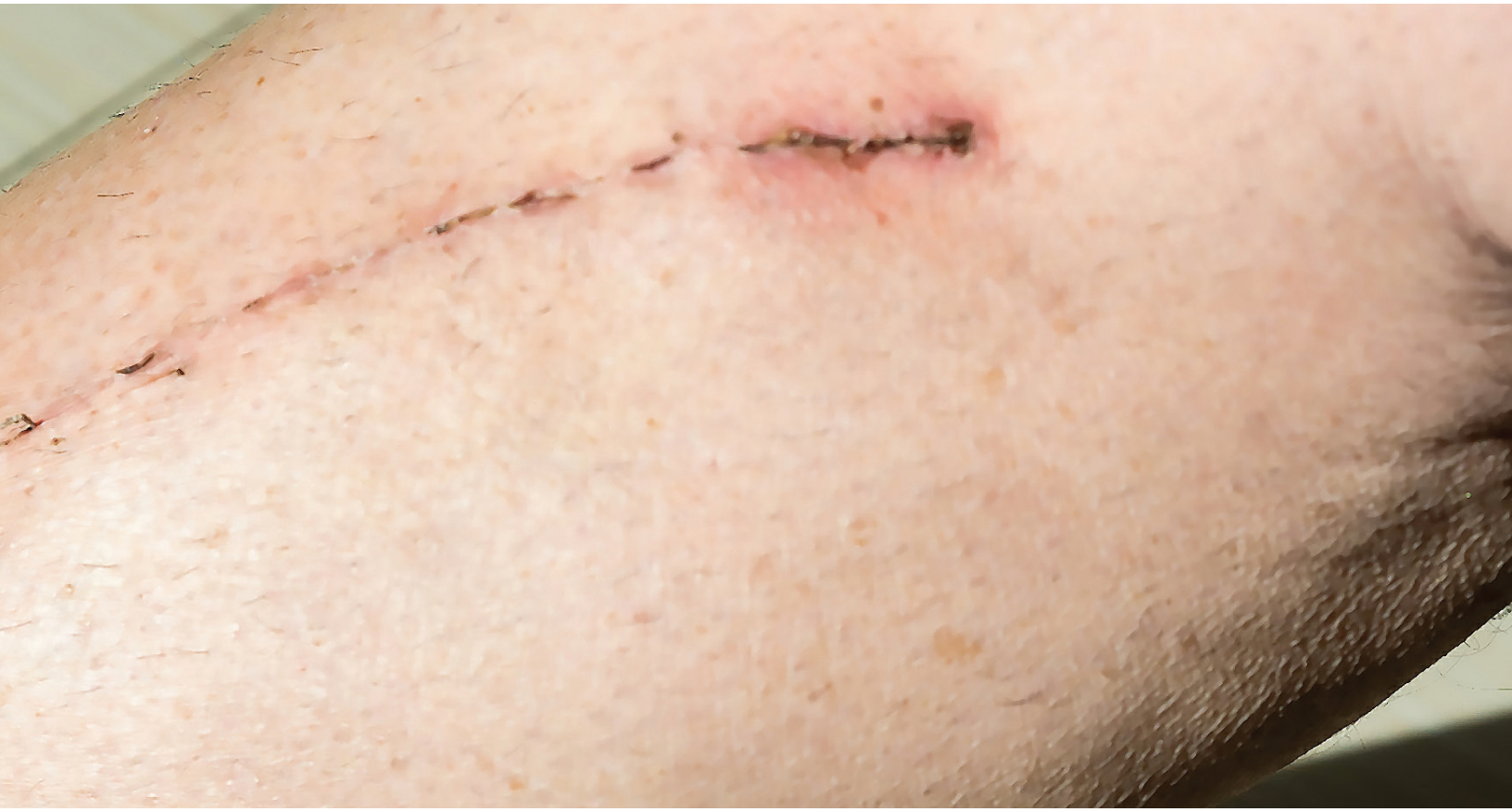
When caring for patients with CLTI, the team should include individuals who are skilled in endovascular and surgical revascularization, wound healing therapies, foot surgeery and medical management.

For further information related to assembling a team, refer to Best Practice Recommendations for the Prevention and Management of Wounds.[21]

3.2 Enlist the patient, family and caregivers as part of the team.

Ischemic and claudication pain, loss of function and mobility, depression, anxiety, embarrassment, social isolation, financial burden, prolonged hospital stays, and chronic morbidity or death are all commonly associated with PAD.[102-113] The last 30 years have been marked by a distinctive growth and mobilization of patient-centred associations that have fostered both advocacy and awareness, as well as partnerships, in an effort to develop better patient outcomes for persons with chronic diseases such as PAD.[114] Engaging individuals who live with PAD/LEAD in the management of their chronic illness is imperative.

The Chronic Care Model (CCM) is designed to help improve patient health outcomes for populations such as those with LEAD. This model of care encourages delivery of



ambulatory care services through several integrated system initiatives designed to make patient-driven, evidence-based care easier to deliver.[115-117]

3.3 Ensure organizational and system support.

Organizational support for arterial wounds is limited. In 2007, an exploratory study in Quebec revealed the lack of collaboration and consistency among health professionals and difficulty in accessing professionals specialized in complex wound care.[118] In 2013, the Canadian Institute for Health Information (CIHI) looked at the prevalence of compromised wounds in Canada by type, health-care setting and risk factors to inform better prevention and management of wounds.[119]

Unfortunately, CIHI reported venous ulcers and arterial ulcers in the same category, not distinguishing wound type clearly enough to provide information relating to specific organizational or system support needs. In a survey carried out to determine knowledge levels and attitudes regarding lower extremity ulcer care, the following problems were reported: lack of evidence-based clinical practice guidelines for leg ulcer care (82%), absence of evidence-based protocols in home-care agencies (72%), lack of access to wound care products (69%), lack of access to wound care centres (66%), and poor communication among health-care workers (60%).[112] Transfer of knowledge from research to practice is poorly funded, and literature reports that it is a slow and challenging process.[120] Delays in knowledge translation often mean treatments and modalities that have proven beneficial may not be readily available or recognized because the evidence has not yet been incorporated into current health-care policy and procedure. This document is the first Canadian best practice recommendation that has been dedicated primarily to the prevention and management of arterial ulcers. Only a few are currently available worldwide.[8,12,60]

According to current guidelines for the prevention of lower extremity arterial ulcers, there have been numerous educational efforts, such as national advertising campaigns, designed to promote increased public awareness of PAD/LEAD and the prevention of arterial ulcers. These types of campaigns should be continued more broadly to provide:

- Information for patients, care partners and health-care providers in all care settings
- A system to identify at-risk patients
- Risk reduction measures
- Prompt, effective treatment
- Service audits to align local practice with accepted standards of care

Overall, such programs should be built on a structure designed to meet the needs of patients who require chronic care.[8,121]

Developing system-supported strategies that focus on the prevention and management of risk factors for arterial ulcers is essential if better patient outcomes are to be achieved. Raising awareness of these risk factors will support early diagnosis and intervention, impacting both the incidence of arterial ulcers and mortality.[12]

To support quality of care, health-care systems will also have to generate higher quality data for all long-standing wounds across all health-care settings.[119] Improving recording and reporting of the prevalence and incidence of wounds, the progression of healing and outcomes of all wound types is also significantly important.[119] With better and more consistent data, the process of translating research into treatment and intervention becomes easier, with a stronger influence on improving the overall quality of patient care.[120]

Step 4: Establish and Implement a Plan of Care

Step 4: Establish and Implement a Plan of Care

An effective plan of care needs to be both evidence-based and allow for patient participation throughout the decision-making process. Successful chronic disease management requires the patient and their care partners be engaged in a plan of care designed for prevention and management.

Recommendations

4.1 Identify and implement an evidence-based plan to correct the causes or co-factors that affect skin integrity, including patient needs (physical, emotional, social), the wound (if applicable) and environmental/system challenges.

An individual diagnosed with PAD/LEAD may be asymptomatic. In such cases the interprofessional health team should still work collaboratively to monitor and to manage risk factors and to ensure that appropriate strategies are implemented to prevent the loss of skin integrity.

Preventative and management plans of care for a person with PAD often include addressing smoking, nutrition, medications, exercise and activities of daily living, chronic pain, offloading and factors that affect quality of life.[58] Patients who have been diagnosed with ALI often require urgent referral to a vascular surgeon to determine the appropriateness of revascularization to restore blood flow in accordance with surveillance protocols.[9,58]

Skin and Nail Care

PAD/LEAD impacts the layers of the skin, making the tissue susceptible to injury. Therefore, the skin on the lower extremities should be protected from trauma caused through mechanical, chemical and thermal insults;[102] otherwise, even minor injuries can lead to significant tissue loss, infection and failure to heal. Appropriate foot care, including skin cleansing, foot inspection, podiatry care and prompt assessment of lesions, is recommended for an individual diagnosed with PAD/LEAD.[58] Care of the toenails on the limb that has evidence of PAD/LEAD or peripheral neuropathy should be performed by a specialist.[12]

Smoking

Patients should be actively encouraged to engage in a smoking cessation program.[4] Referral to such a program, along with counselling and pharmacotherapy support, is strongly recommended;[58] cessation in patients with asymptomatic PAD optimizes the patient's tolerance to ambulation.[50,58] Unless contraindicated, the following pharmaceutical approaches to smoking cessation should be considered: varenicline, nicotine replacement therapy and bupropion.[58] When patients are not ready to stop smoking completely, a reduction in smoking by half or the use of an electronic cigarette are recommended as alternative options; however, the long-term safety of electronic cigarettes is unknown.

Glycemic Control

Effective glycemic control is recommended for patients with asymptomatic PAD.[58] For most adults with diabetes, Diabetes Canada proposes a HbA1c target of ≤7.0%. For people with type 2 DM at low risk of hypoglycemia, a lower target of ≤6.5 is rec-

ommended. However, a target HbA1c between 7.1% and 8.5% may be the preferred measure in a person with PAD when other comorbidities such as limited life expectancy, recurrent severe hypoglycemia and/or hypoglycemia unawareness, functional dependency, frailty, advanced age or dementia are present.[111]

When poor glycemic control is a suspected factor, patients with LEAD should be encouraged to follow up with their primary health-care provider, diabetes educator or other appropriate specialist for supportive services, technologies or devices that could optimize glycemic control. For more information, please refer to Best Practice Recommendations for the Prevention and Management of Diabetic Foot Ulcers.[122]

Physical Activity

Exercise programs should be considered for patients with LEAD as a risk reduction strategy and as an alternative to revascularization, particularly in the early stages of the disease. Structured, supervised exercise programs are recommended as first-line therapy for the treatment of IC.[58] Unsupervised exercise may have some benefit when supervised programs are not feasible.[9] These programs aim to manage the symptoms of IC by improving exercise capacity, preventing or minimizing physical disability and reducing the occurrence of CV events. Taking into consideration that patients with LEAD belong to a high-risk population, careful monitoring and evaluation of existing comorbidities is recommended to ensure patient safety during exercise.[45]

Existing functional limitations associated with claudication pain, along with an evaluation of how well a patient is responding to therapy, are most objectively measured through exercise treadmill tests. Treadmill walking is one example of an exercise program that can be structured and supervised and has demonstrated the best evidence for managing symptoms of IC.[62] Exercise sessions involve selecting a walk-

ing speed and degree of incline that will induce symptoms of IC within three to five minutes. When a patient reports moderate claudication pain, they are instructed to stop and rest until the symptoms subside. The exercise cycle is repeated for at least 30 minutes. In subsequent visits, the speed and/or degree of incline of the treadmill can be increased if the patient is able to tolerate walking for 10 minutes or longer at the increased workload without experiencing IC. Exercise sessions longer than 30 minutes and more often than three sessions per week are considered to have the most benefit.[62] Sessions lasting longer than 26 weeks demonstrate the longest-lasting benefit.[5] Alternative forms of exercise may also benefit the patient, including brisk walking, cycling, stair climbing and dynamic leg exercises. However, current evidence suggests that these are not as effective as treadmill training.

Home-based, self-directed exercise programs are recommended, and may also be of benefit to patients who do not have access to a supervised program.[62] Home-based programs should have a goal of 30 minutes of walking three to five times per week.[45]

The presence of lower-extremity wounds and severe IC may potentially exclude a patient from participating in a treadmill exercise training program. As an alternative option, arm ergometry has been shown to improve lower extremity perfusion and alleviate pain in patients with known PAD.[123] Participating in a supervised or home-based exercise program is recommended for patients who have undergone a revascularization procedure.[45]

Medications: Pre-revascularization

Medications prescribed for the treatment of PAD/LEAD are outlined in Table 11, in consideration of four clinical objectives: cardiovascular risk reduction, claudication management, CLTI management and treatment for limb preservation. Cardiovascular

Table 11: Cardiovascular Risk Reduction and Claudication Management Considerations [9,58,62]

Lipid-lowering Agents	
Statins	▪ Recommended for all persons with PAD/LEAD to achieve a target LDL-C < 2.0 mmol/L or 50% reduction of LDL-C (modified target < 1.8 mmol/L if at very high risk of ischemic events). Alternative target variables are apoB < 0.8 g/L or non- HDL-C < 2.6 mmol/L
Ezetimibe	▪ Recommended as second-line therapy (add-on to statin) if target LDL-C not reached with maximally tolerated statin therapy
Bile acid sequestrant	▪ Does not reduce CV risk but should be considered in persons with PAD/LEAD who are unable to achieve LDL-C target in combination with maximally tolerated statin therapy doses with or without ezetimibe.
PCSK9 inhibitor	▪ Considered in persons with PAD/LEAD who are unable to achieve LDL-C target in combination with maximally tolerated statin therapy doses with or without ezetimibe.
Fibrate	▪ Does not reduce CV risk, but should be considered in persons with PAD/LEAD and low HDL-C, and/or elevated triglycerides, to reduce the LDL-C values
Antihypertensive agents	▪ Considered for selected high-risk patients, aged ≥ 50 years, and with systolic blood pressure (SBP) levels ≥ 130 mmHg, intensive management to an SBP ≤ 120 mmHg[124-125] ▪ Patients with diabetes should be treated to attain < 130 mmHg SBP and < 80 diastolic BP mmHg[125] ▪ Other patients should be treated to attain < 140 mmHg SBP and < 90 mmHg diastolic BP[124]

cont'd.

ACE inhibitors	▪ In symptomatic patients with lower extremity PAD/LEAD, these can reduce the risk of adverse CV events. In asymptomatic patients with lower extremity PAD/LEAD, they may reduce the risk of adverse CV events.
Antiplatelet and Antithrombotic Agents	
1st Line: ASA 75 mg to 325 mg daily	▪ For individuals with symptomatic atherosclerotic LEAD—including those with IC or CLTI—prior to lower extremity revascularization (endovascular or surgical), or prior amputation for lower extremity ischemia to reduce the risk of myocardial infarction (MI), stroke and vascular death
2nd Line: Clopidogrel 75 mg daily	▪ In asymptomatic individuals with an ABPI ≤ 0.90, consider antiplatelet therapy to reduce the risk of MI, stroke, or vascular death. (Note: When ABPI is 0.91–0.99, reduction in MI, cerebrovascular accident (CVA) or vascular death in asymptomatic individuals is not well established.)
Combination: ASA + clopidogrel	▪ Considered for those who are not at increased risk of bleeding and who are at perceived high cardiovascular risk with symptomatic atherosclerotic LEAD, including those with intermittent claudication or CLTI, prior lower extremity revascularization (endovascular or surgical), or prior amputation for CLTI to reduce the risk of CV events
Combination: Warfarin + ASA or clopidogrel **Combination: New oral anticoagulants (NOAC) + ASA**	**NOT RECOMMENDED** ▪ In the absence of any other proven indication for warfarin, its addition to antiplatelet therapy to reduce the risk of adverse CV ischemic events in individuals with atherosclerotic PAD/LEAD is of no benefit and is potentially harmful due to increased risk of major bleeding. ▪ The COMPASS trial suggests that the combination of ASA 100 mg QD and rivaroxaban 2.5 mg BID is associated with a reduction of amputations and major cardiovascular events, but is also associated with an increased risk of major bleeding[126-127] **Caution is warranted** given the incremental bleeding risks associated with combination therapy and because existing evidence is inadequate to support a confident recommendation at this time.
Homocysteine-lowering Agents	
Folic acid and vitamin B12 supplements	▪ Effectiveness is not well established in individuals with PAD/LEAD and homocysteine levels ≥ 14 mmol/L.
Oral zinc	▪ Does not appear to aid in healing arterial wounds[128]
Intermittent Claudication Management Considerations	
Statins	▪ Indicated to improve walking distance when prescribed in conjunction with general prevention strategies[9]
Pentoxifylline 400 mg 3x per day	▪ May be considered to improve walking distance in patients with IC. Note: The clinical effectiveness of pentoxifylline as therapy for claudication is marginal and not well established. ▪ Not recommended as a useful agent for the treatment of CLTI[58]

risk-reduction medications include lipid-lowering agents, antihypertensive agents, antiplatelet and antithrombotic agents, smoking cessation options and antihyperglycemic agents.

Medications: Post-revascularization

The presence of asymptomatic or symptomatic LEAD is an ominous sign that widespread atherosclerosis is present. Patients who experience rest pain in a lower ex-

tremity, or have developed an arterial ulcer, have a significantly increased risk of myocardial infarction and cardiovascular accident and cardiovascular-related death.[129-130] Pharmacological management is recommended for risk reduction and can play a significant role in reducing the prevalence of morbidity and mortality.[12,83] Even if blood flow has been restored or optimized in a lower extremity, targeted medical therapy is indicated to prevent further cardiovascular events or the progression of LEAD.

Pharmaceutical therapies can be grouped into three categories: thrombosis-directed therapies, cholesterol-lowering therapies and blood-pressure-lowering (anti-hypertensive) therapies. Standard treatment guidelines for medical therapy (including beta blockers, statins, angiotensin-converting enzyme [ACE] inhibitors and calcium channel blockers) will improve outcomes for not only coronary artery disease (CAD), but also arterial ulcers. See Table 12 for a description of these medications.[8]

Imaging Studies to Optimize the Revascularization Strategy

Arterial imaging is not used only to diagnose LEAD. When a revascularization procedure is being considered, advanced imaging may be employed to identify the target vessels (vessels with lesions) and to determine the most appropriate approach to revascularize the limb. If a normal post-exercise ABPI measurement is obtained, arterial imaging is not recommended, in accordance with surveillance protocols.[58]

Table 12: Pharmacotherapy for CLTI and Post-revascularization Medications

Pharmacotherapy for CLTI	
Thrombosis-directed agents	**Antiplatelet Agents** ▪ Long-term single antiplatelet therapy recommended for asymptomatic PAD[9] ▪ Recommended in accordance with surveillance protocols ▪ Recommended for patients with PAD who are symptomatic for IC or have CLTI, to reduce the risk of MI, CVA and vascular death[14,82,131] ▪ Recommended for patients with asymptomatic PAD to reverse adverse cardiovascular ischemic events[58] ▪ Clopidogrel 75 mg daily is recommended as a safe and effective alternative antiplatelet therapy to ASA to reduce the risk of MI, CVA, or vascular death in individuals with symptomatic atherosclerotic PAD.[82] Current guidelines report that clopidogrel may be preferred over ASA. ▪ Certain high-risk PAD patients benefit from receiving both ASA and clopidogrel; however, it is recommended that this combination therapy be considered on an individual basis, and not for patients with high risk of bleeding.[132] ▪ No clinical trials have examined the efficacy of newer antithrombotic medications such as prasugrel or vorapaxar to reduce ischemic events in patients with PAD.[46] ▪ No difference in MACE (major adverse cardiovascular events) and MALE (major adverse limb events, e.g., major amputation) when comparing ticagrelor and clopidogrel[133] **Anticoagulation Agents** ▪ There is evidence for prescribing moderate intensity anticoagulation (INR 2-3) in the presence of ASA, suggesting that combining anticoagulant and antiplatelet therapy significantly reduces recurrent CV events; however, this combination also increases the risk of major bleeding. ▪ The effectiveness of oral anticoagulation (OAC) and ASA in PAD patients is of no benefit and is potentially harmful due to increased risk of major bleeding.[82]

cont'd.

Cholesterol-lowering agents	▪ Strong evidence supports the lowering of cholesterol with statin medications in patients with LEAD to reduce the risk of major vascular events.[58] ▪ Lipid-lowering therapy is recommended for patients with asymptomatic PAD.[58] ▪ Lipid-lowering therapy with a statin is recommended for patients with PAD who have a total cholesterol level > 3.5 mmol/L.[58] ▪ Treatment with simvastatin 40 mg daily in patients with vascular disease or diabetes was shown to have a 24% relative risk reduction and 5.5% absolute reduction in major vascular event risk when compared with those treated with a placebo. These effects were observed irrespective of the baseline LDL cholesterol.[44]
Antihyperglycemic agents	▪ Optimizing glycemic control is recommended for patients with CLTI.[9]
Antihypertensive agents	▪ Treatment of hypertension recommended to reduce cardiovascular events, including congestive heart failure (CHF), CVA and death. There is some evidence to suggest a definite relationship between hypertension and LEAD. ▪ Effective management of hypertension recommended for patients with asymptomatic PAD[58] ▪ Recommended that patients without diabetes who have been diagnosed with PAD and hypertension be prescribed antihypertensive medication to achieve a blood pressure measurement of <140 mmHg systolic[5] ▪ Recommended that the treatment goal for PAD patients with diabetes and/or renal disease should be blood pressure of <130 mmHg systolic over 80 mmHg diastolic.[58] Treatment with an ACE (angiotensin-converting enzyme) inhibitor medication is recommended to lower CV risk in patients with either asymptomatic or symptomatic PAD.[58] ▪ Ramipril should be considered as a first-line choice for hypertension treatment in PAD patients; although it should be used with caution in the presence of renal artery stenosis.[50] ▪ Beta-blockers are widely used for the management of high blood pressure, either alone or combined with other medicines, including diuretics, ACE inhibitors or calcium channel blockers. May be especially useful in people who also have angina or heart failure, or who have had a heart attack. ▪ There is no available evidence that beta-adrenergic blockers worsen the symptoms of IC.
Post-intervention (Revascularization) Medications[68]	
Antiplatelet agents	▪ Clinical evidence does not conclusively support the routine use of antiplatelet agents to improve lower extremity vein bypass graft patency. ▪ Long-term single antiplatelet therapy is recommended for patients who have undergone revascularization.[9] ▪ Use of anticoagulant therapy is still recommended to reduce future cardiovascular ischemic events and incidence of stroke. ▪ Bypass graft patency may be improved with antiplatelet therapy in patients undergoing prosthetic bypass. ▪ Antiplatelet therapy recommended for all patients undergoing revascularization for CLTI, and continued post-operatively, unless contraindicated by a pre-existing condition.[58]
Anticoagulation agents	▪ The use of warfarin anticoagulation following lower extremity bypass remains controversial. ▪ Anticoagulation is used selectively in vein bypass procedures when the graft is not considered to be optimal quality or vessels below the graft site are small or diseased. ▪ Warfarin, in addition to ASA, is prescribed to many patients receiving prosthetic grafts to reduce the ischemic consequences of bypass graft thrombosis. ▪ **Caution is warranted** given the incremental bleeding risks associated with combination therapy and because existing evidence is inadequate to support a confident recommendation at this time.[50]

Intermittent Claudication (IC): Medical Management versus Revascularization

Patients who experience IC should be considered for medical management before being offered endovascular and surgical therapies. The cornerstones of management for patients who experience intermittent claudication are cardiovascular protection and exercise.[9]

Surgery still plays an important role in the treatment of patients with arterial disease. When PAD results in impairment of normal activities of daily living (ADLs) or incapacitating IC, revascularization should be considered.[9] If there is severe impairment of ADLs, exercise therapy should be considered, along with revascularization.[9] Choosing the most appropriate intervention, open or endovascular, will depend on the location and distribution of the arterial lesions, as well as the patient's overall condition and comorbidities.

Endovascular therapy is used more commonly than open surgical therapy because of its minimally invasive nature and the reduction of short-term morbidity and mortality. The trade-off, however, is the long-term durability of endovascular repairs.

CLTI and Revascularization

To alleviate pain, improve the patient's HRQoL, close any existing arterial ulcers and prevent amputation, most patients will require some form of revascularization procedure.[4] In addition, an aggressive plan of care aimed at managing all existing cardiovascular risk factors is essential. Revascularization is a fundamental strategy for limb preservation and is the optimal treatment choice for patients with CLTI.[4] However, in some cases, revascularization does not improve limb function and mobility. Cognitive impairment, a non-ambulatory status prior to developing CLTI, and severe comorbidities may lead to a poor prognosis even when revascularization has been performed.

Acute Limb Ischemia (ALI) and Revascularization

When ALI occurs, assessment and emergent revascularization should be carried out if the affected extremity is considered a candidate for preservation.[4,58] In contrast to treating chronic ischemic disease, current guidelines do not recommend investigative tests to determine the vascular anatomy (or sites of occlusion) when the affected limb is not considered a candidate for preservation.[58] If a neurological deficit underlies the acute ischemia, urgent revascularization is recommended.[9] In the case of acute ischemia, treatment with heparin and analgesics to manage pain are recommended as soon as possible.[9]

Managing Pain: Wound Pain, IC and CLTI

The presence of tissue ischemia or neuropathy will require the clinician's careful attention to pain. Management of pain associated with an arterial ulcer should include a consideration of local, regional and systemic modalities.[60] One of the primary strategies to reduce pain associated with LEAD is to encourage the patient to position the lower limb in a dependent position to optimize perfusion to the wound. Making appropriate adjustments to sleeping position by increasing foot dependency can optimize rest and reduce night pain but will result in increased swelling of the lower extremities.

The presence of IC and CLTI can cause considerable discomfort and should be managed vigilantly. Current literature reports that the application of an ibuprofen-foam (IBU) dressing may provide some local wound pain relief, as well as increase HRQoL;[134-135] however, there is no available evidence that recommends the routine use of these dressings to treat arterial ulcers specifically for the purpose of pain management. More high-quality studies will have to be carried out before any conclusions can be made.[78,135]

Several studies have reported positive benefits of the use of statins to reduce IC pain.[46,58] A few small studies have demonstrated a benefit of statin therapy to optimize pain-free walking time in patients with IC, although the mechanism of action is not known.[50,109-110]

The 2006 HOPE trial reported that prescribing ramipril 10 mg once daily was associated with an increase in pain-free and maximal treadmill walking times and in measures of physical function.[136] Further studies are needed to confirm both the benefit and safe protocols with this population.[137] However, a 2015 guideline suggests that prescribing ramipril 10 mg once daily should be considered to improve pain-free and maximal walking times in patients with IC.[50]

Pentoxifylline is a medication often prescribed for its action to reduce blood viscosity and platelet aggregation. A 2015 review concluded that there is currently insufficient high-quality data to support the benefits of pentoxifylline for IC.[138] Although pentoxifylline has not been shown to improve arterial ulcer healing,[60] a modest effect in increasing pain-free and maximal walking distance has been demonstrated. This is believed to be a result of improving blood flow and enhancing tissue oxygenation.[139-140]

Although the clinical effectiveness of pentoxifylline for the treatment of IC is not well established,[109-110] best practice guidelines recommend that pentoxifylline be considered for these patients to improve walking distances.[58]

The use of acetaminophen, in conjunction with opioids, should be considered for the management of pain associated with CLTI.[137] When pain is not adequately controlled, a referral to a specialist with expertise in pain management is recommended, and revascularization should be considered to augment wound healing and limb preservation.[45]

Nutrition

Nutritional counselling may be recommended for patients with LEAD and CLTI to determine deficits that may impact the healing of the arterial ulcer.[62] The role of oral zinc to augment the healing of arterial ulcers is not well established.[128]

Nutrition must be adequate to provide sufficient protein to support the growth of granulation tissue.[8,12,69-70,74-75,99,141] For further information refer to Best Practice Recommendations for the Prevention and Management of Wounds.[21]

Psychosocial Factors

Patients with CLTI who are not considered candidates for revascularization have lower reported HRQoL. These lower scores relate specifically to a reduction in physical functioning, activities of daily living and physical pain. HRQoL scores are reportedly lower in females with LEAD, individuals with a higher body mass index (BMI) and/or reduced ABPI.[142] Social isolation, alcohol consumption, poor hygiene and nutrition have been implicated as psychosocial factors that contribute to the development of arterial ulcers. Securing the support of a social worker, outreach programs and/or a spiritual care specialist may be beneficial to improving HRQoL.[143]

Offloading for Wound Prevention and Healing

As a preventative measure in persons with LEAD, an orthotic, shoe or other offloading device can minimize the pressure over vulnerable areas on the lower extremity. This is particu-

larly important when peripheral neuropathy is present. It is essential that patients with PAD/LEAD receive a biomechanical assessment as soon as possible by a trained professional to ensure the appropriateness of footwear and other orthotic/prosthetic devices that may contribute to extrinsic pressures.[58,62] Every effort needs to be made to prevent pressure injury, particularly over boney prominences, and reduce the risk of wounds caused by trauma.[58]

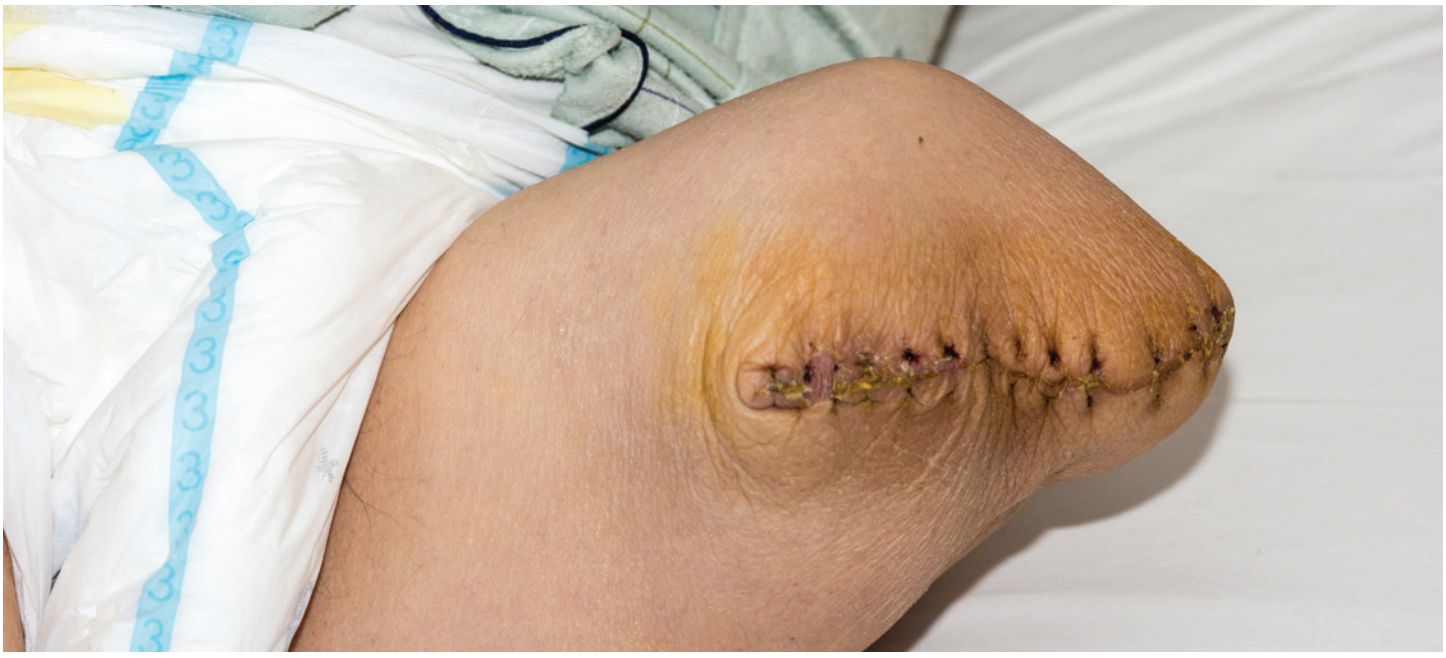
When an arterial ulcer is present it may be necessary to modify the existing offloading device/orthotic to an alternative that will support wound healing and prevent further tissue breakdown.[62]

Consultation with a health-care clinician who is skilled at carrying out a biomechanical assessment of the lower limbs (pedorthist, chiropodist, podiatrist, orthotist) is recommended to determine the most appropriate offloading approach and/or device to use. For further information on offloading devices refer to Best Practice Recommendations for the Prevention and Management of Diabetic Foot Ulcers.[122]

Limb Amputation

Amputation for chronic ischemia may be performed as the result of a failed revascularization attempt, a lack of suitable conduit or target arteries, severe patient comorbidities, poor functional status, or extensive gangrene or infection such that limb preservation is not possible.[144] The goals of amputation are to eliminate all infected, necrotic and painful tissue, to achieve uncomplicated wound healing and to have an appropriate remnant stump that can accommodate a prosthesis.[144]

Major amputation (above the ankle) in patients with CLTI is recommended when there is overwhelming infection that threatens the patient's life, rest pain cannot be controlled and there is extensive tissue loss.[4,145] Amputation should be considered for a patient with significant necrosis on the weight-bearing portions of the foot, non-correctable flexion contracture or very limited life expectancy as a result of comorbidities.[14,16] Lower limb amputation (LLA) is a disabling and costly condition.[146] Cost estimates are not available for Canada; however, in the United States the costs associated with acute and post-acute care for LLAs exceeds $4 billion annually.[146]



A recent Canadian study on 20,062 patients in Ontario observed a significant increase in the rate of any amputation among patients with diabetes, peripheral arterial disease, and both diabetes and periphery arterial disease.[147] In the study, 64 of patients underwent a major (above ankle) amputation. Diabetes was present in 82%, peripheral arterial disease in 94%, and both diabetes and peripheral artery disease in 76%.[147]

With the growing aging population and the expected growth in the number of individuals living with lower limb amputation, it is imperative that adequate rehabilitation resources, foot screening and diabetes-management programs are available to this population and are allocated appropriately.[148] In a population-based descriptive study in Canada, Kayssi et al., (2016) found that there is variability in the delivery of lower-extremity amputations and postoperative hospital discharges among surgical specialists and regions.[149]

The length of the residual limb has important implications for rehabilitation.[144] Whether the patient has undergone a trans-met amputation (TMA), a below-knee amputation (BKA) or an above-knee amputation (AKA), they will require interventions related to ambulation and mobility, adjustment to new body image, management of phantom limb pain and social and environmental adaptations. A proper assessment is essential to determine whether an amputee is an appropriate candidate for a prosthetic device. Advanced prosthetic technology provides amputees with more choices, new functional designs and ultralight materials help with independent living.[144] Measuring for and the fitting of a prosthetic device should be carried out by a trained professional who has expertise in the biomechanical assessment of the lower extremities, as well as other physiological considerations related to lower-limb amputation.

Ulceration is an ongoing concern with the introduction of a prosthetic because the device can be a cause of external pressure injury and discomfort. The patient's overall safety is a priority.

Some important factors to consider in the choice of a prosthetic design are the patient's comfort and sense of safety, appearance of the device, functionality, social circumstances, user-friendliness, cost and maintenance. Collaboration among specialists is essential to support these patients following hospital discharge and to ensure regular servicing of the prosthetic. Regular reassessment may identify a change in the patient's level of function and mobility, weight changes and impact on the fitting of the device or other concerns regarding safety and comfort.

Phantom Limb Pain (PLP)

Post amputation, the complication of PLP is prevalent and difficult to manage.[91] Various therapies have been explored to determine the best approach to managing PLP; however, none has been found to be highly effective.[92] There are currently no published systematic reviews or meta-analyses dedicated to evaluating therapies for managing PLP.

Currently employed non-invasive and minimally invasive therapies for PLP include medications, exercises and relaxation techniques, transcutaneous electrical nerve stimulation (TENS) and acupuncture.[142-143] More-invasive options include anesthetic and steroid injections, spinal cord stimulation (SCS) and nerve blocks. Surgical stump revision and neurectomy are sometimes considered as a last resort.

Some evidence has been generated for the prevention of PLP before the amputation is performed with the use of pre-operative anesthetic.[92] Another RCT studied PLP management after amputation and concluded, "The use of a prolonged postoperative peri-

neural infusion of anesthetic (ropivacaine 0.5%) seems to be an effective therapy for the treatment of phantom limb pain and sensations after lower extremity amputation."[151]

Psychological Considerations Following Lower Limb Amputation

Having one or more lower extremities amputated as a result of PAD/LEAD can result in a number of emotional responses, including grief (sense of loss) and an alteration in body image. An individual's level of functioning and their ability to carry out activities of daily living are often associated with body image. Adapting to a new body image and a change in function are keys to accepting the amputation and enhancing quality of life.[152-154] A timely referral to a psychologist or psychiatrist trained in dealing with amputation can help the patient explore their sense of grief and loss and transition to an acceptance of a new body image and level of functioning.[152]

Environmental adaptations in the home, such as grab bars and modified bathrooms, can optimize function and foster a greater sense of independence and self-care. This is particularly important when the patient is being considered for or has been fitted with a prosthetic limb or is required to mobilize with other devices such as a wheelchair or walker. The support services of a PT and/or OT can optimize the amputee's physical strength, balance and co-ordination, as well as introduce skills and techniques related to transfer and mobilization.[152]

Social workers are often helpful in accessing community-based resources and services for the patient to aid in the process of adapting to a new amputation.

4.2 Optimize the local wound environment.

Strategies that are designed to manage the wound should reflect the goals of care for the patient. Determining the healability of an arterial ulcer is essential to guide decisions about local wound care. Healing requires a greater increase in perfusion than is needed to maintain intact skin.[4] An arterial wound that has adequate perfusion is considered healable. It will have a more aggressive approach with a goal of wound closure. Non-healing and non-healable wounds, where blood perfusion is inadequate or factors that impact healing cannot be addressed, the goals will not revolve around wound closure, but will focus on pain control and preventing infection.[1,78,135] Preventing re-ulceration and minimizing further tissue damage should always be a priority with patients who have PAD/LEAD.

4.2.1 Cleansing

For wounds that are considered to have adequate arterial perfusion, pH-balanced, non-cytotoxic skin and wound cleaners should be used to maintain the skin's moisture barrier and acid mantle and promote a moist wound healing environment.[62] Arterial ulcers that are considered to have adequate blood flow to heal may benefit from the use of cleansers that contain antiseptics and surfactants.[155]

The cleansing of non-healable arterial ulcers that present with dry eschar or dry gangrene is not recommended.[12,67]

It is recommended that dry gangrene or eschar be left dry until revascularization is successful;[12] therefore the cleansing of these arterial wounds should be carried out with the daily application of povidone iodine (10% PVP-I) to maintain a dry wound bed.[78,135,156]

Surgical debridement of nonviable and non-infected tissue is not recommended until adequate vascular status has been confirmed or restored.[12,100]

Without adequate perfusion to heal the wound, debridement may exacerbate tissue ischemia by increasing metabolic demand, leading to increased risk of amputation.[12]

Washing or cleaning a non-healable wound site before the application of 10% PVP-I is not recommended.[60,76] Gangrenous tissue, if not infected, can form an eschar cap that will progressively shrink as it dries and eventually "mummify."[4] If the circulation beneath or surrounding the wound is adequate (or improved by a revascularization procedure), a process of auto-amputation may follow.[4] This process, however, may take considerable time, and pain management, education in bacterial burden, and maintaining a dry wound environment become the priorities.[4,78,135,156]

For further guidance on wound cleansing refer to Best Practice Recommendations for the Prevention and Management of Wounds[21] and Wounds Canada's Product Picker: Skin and Wound Clean Up.

4.2.2 Debriding

All current guidelines on arterial ulcers are consistent with the practice of not debriding stable black eschar.[62,76,98,102]

Debridement prior to revascularization in poorly perfused extremities should be performed only in a septic foot with and without ischemic signs.[12]

Autolytic and enzymatic debridement may be alternative approaches to consider in cases where sharp debridement may be contraindicated. However, autolytic and enzymatic debridement are contraindicated in the presence of significant PAD.[153] When employing these modalities with an ischemic wound, close monitoring is recommended.[62] For further guidance on wound debridement refer to Best Practice Recommendations for the Prevention and Management of Wounds.[21]

4.2.3 Managing bacterial balance

A progression of PAD often coincides with an increased risk of wound infection.[11] The probability of infection varies directly with increasing bacterial numbers and their relative ability to cause disease (known as virulence) while varying inversely with the host's ability to resist invasion.[156]

The application of topical antimicrobial dressings should be considered to minimize the proliferation of bacteria in the open wound.[12,62] Povidone iodine (10% PVP-I) is one

of the most extensively used broad-spectrum topical antiseptics used to minimize the bacterial burden in long-standing wounds with an inadequate blood supply.[78,135] PVP-I is available in an aqueous solution, as well as being impregnated into products that have a sustained-release delivery system. These newer technologies can support fiscal responsibility by reducing both the frequency of dressing changes and visits with a health-care professional.

However, it is important to consider that formulations of PVP-I, such as liposome hydrogel (3%) and cadexomer-iodine (0.9% iodine), may enhance moist wound healing and may not be appropriate for non-healing arterial ulcers.[78]

When it is suspected that an arterial ulcer has become infected, the use of a topical antimicrobial dressing is not considered to be sufficient treatment.[62] Systemic antibiotic therapy is required in patients with CLTI who develop spreading or systemic infection.[4] Clinical signs of infection may be subtler because of the decrease in blood flow to the site of the arterial ulcer.[62] Clinical infection should be suspected when the ulcer becomes more painful, or the local wound site begins to deteriorate or fails to heal.[60] PAD/LEAD-related wound infection is a primary risk factor for major amputation.[13,27]

For further guidance on maintaining bacterial balance refer to Best Practice Recommendations for the Prevention and Management of Wounds.[21]

Antibiotic Selection

Rapid assessment and diagnosis of infection associated with PAD, including a consideration of extent and severity of tissue involvement, can facilitate timely intervention.[4]

It is recommended that a patient with PAD and CLTI be referred promptly to a vascular surgeon when infection is suspected.[14,58,77] Best practice guidelines recommend that patients with CLTI, skin ulcerations and evidence of limb infection be promptly treated with systemic antibiotics.[14,58,77,158] A patient with an infected arterial ulcer should be evaluated as soon as possible by a clinician expert in determining the appropriate culture-guided antimicrobial treatment.[60] Wound cultures and tissue and bone biopsies can guide culture-specific treatment. Where no cultures are available, or prior to

culture processing, empiric broad-spectrum antibiotics should be initiated in consultation with an infectious disease specialist whenever possible. Adjustment of antibiotics should be made once the causative micro-organisms and culture and sensitivity have been obtained.[77,158] Additional caution should be exercised when prescribing antibiotics to a patient with renal insufficiency to ensure effective clearance of these medications. In such cases, consultation with a nephrologist, or pharmacist for renal dose calculations, may be warranted to ensure patient safety. There is a growing practice of engaging a pharmacist for prescription of antimicrobials to treat infection. Currently this practice varies from region to region in Canada. The appropriateness of consulting a pharmacist depends on the scope of practice and expertise of individual pharmacists, and should be carried out in collaboration with the specialist physician who attends the patient.

4.2.4 Managing moisture balance

Maintaining moisture balance in the local wound environment is recommended for arterial ulcers that are considered to have adequate perfusion to heal or after a successful revascularization. Choosing an appropriate dressing can optimize the local wound environment throughout different phases of the wound healing process by helping maintain moisture balance.[76,122] Maintaining moisture balance in the local wound environment has been shown to augment the cellular activity necessary for tissue repair, increase angiogenesis, enhance autolytic debridement, proliferate epithelialization and reduce pain.[21] Careful monitoring is recommended when an arterial ulcer is being treated with a moisture-retentive dressing to ensure that tissues do not become boggy and vulnerable to bacterial growth.[60]

Maintaining a dry wound environment is recommended for non-healable and non-healing wounds, or until adequate blood flow has been re-established or the ischemic digit auto-amputates.[76]

All current BPGs recommend the daily painting of non-healable arterial wounds with 10% PVP-I and covering with a gauze or breathable cover dressing to maintain a dry wound environment.[60,76] If sufficient perfusion can be restored through revascularization, the use of moist wound healing principles should be resumed.[60,76] If a dry eschar becomes moist or boggy clinicians should consider the possibility of wound infection. The progression of infection may be inhibited through surgical wound debridement, and incision and drainage of an existing abscess, before revascularization is carried out.[12]

When an ulcer is considered non-healable because of inadequate perfusion, it is strongly recommended that all sources of moisture, such as foot soaks, creams and ointments, be avoided.[9,12,76]

Timely diagnosis and treatment of infection in peripheral arterial wounds is essential to reduce the risk of systemic infection and amputation.[12] For further guidance on maintaining moisture balance refer to Best Practice Recommendations for the Prevention and Management of Wounds.[21]

4.3 Select the appropriate dressings and/or advanced therapy.

Having a good working knowledge of different classifications and of dressings can assist the clinician in making informed choices so that the wound environment can be optimized at various stages of the healing process.[1,12,60,70,99,159-162] Currently, there is insufficient evidence to suggest that one particular dressing over another will significantly affect the healing of arterial ulcers.[160-163] The healability of the wound and the degree of tissue injury should always be taken into consideration when choosing the most appropriate dressing.[1,78] Moist wound healing and occlusive dressings are not recommended for arterial wounds that do not have sufficient blood flow to heal.[57,73]

However, dressings that provide good ventilation and permit frequent wound inspection are recommended for arterial ulcers.[62] For further guidance on the different

classifications and selection of dressings refer to Best Practice Recommendations for the Prevention and Management of Wounds.[21] For more information about dressing selection, see Wounds Canada's Product Picker: Wound Dressing Formulary and Product Picker: Wound Dressing Selection Guide.

Biologically Active Wound Dressings

Biologically active dressings are believed to influence the levels of proteases and growth factors in the wound environment. There is insufficient literature to support recommending biologically active dressings as a routine treatment for arterial ulcers. More research is required in this area to determine the benefit that biologically active dressings may have on the healing of arterial ulcers.

Advanced Therapies

There is a lack of strong evidence to support the routine use of advanced therapies—such as electrical stimulation, hyperbaric oxygen therapy, intermittent pneumatic compression, negative pressure wound therapy, spinal cord stimulation, topic oxygen therapy and ultrasound therapy—for arterial ulcers (see Table 13). However, it is recommended that advanced therapies be considered to augment the wound healing progress for patients who are at a high risk for amputation.[60] Therefore, advanced therapies should be considered in limited situations when the standard best practice approach to wound healing is not achieving satisfactory outcomes. Access to the advanced therapy, the availability of trained health professionals, cost and appropriateness of treatment are all considerations that should be made prior to the decision

Table 13: Advanced Therapies for the Prevention and Management of Arterial Ulcers

Advanced Therapy	Current Evidence for Use
Electrical stimulation (E-STM)	▪ Does not replace the benefits or outcomes of revascularization[164-165] ▪ Further quality study specific to arterial wounds needs to be carried out to make any conclusions.
Hyperbaric oxygen therapy (HBOT)	▪ Some evidence of benefit in selected patients with ischemic ulcers to augment the wound-healing process[4,12,60,164] ▪ Currently no evidence in literature to support or refute the use of HBOT to treat arterial ulcers[165] ▪ May be considered in selected patients with ischemic ulcers who have not responded to, or are not candidates for, revascularization.[4] ▪ Further research is needed to clarify the benefit for non-diabetic patients with arterial or other ischemic ulcers, or for wounds associated with surgical debridement, revascularization or amputation.[164-165] ▪ Selection criteria should include wounds with hypoxia; tissue hypoxia can be determined with a transcutaneous oximetry measurement ($TcPO_2$) value of < 40 mmHg, with reversibility and responsive to oxygen challenge.[12,60,164] ▪ Some evidence to support consideration in cases of compromised grafts and flaps with concomitant hypoxia and impaired perfusion[166]
Intermittent pneumatic compression (IPC)	▪ The physiological effects include activating the skin's bioelectrical potential, attracting wound healing mediators, stimulating collagen and blood vessel formation, organizing collagen deposition, reducing tissue edema, improving blood flow and perfusion, and generating an antibacterial effect.[167] ▪ Thought to aid in the promotion of local circulation by increasing local collateral circulation, enhancing vasodilation, decreasing venous congestion and edema in the extremity[60]

cont'd.

Negative pressure wound therapy (NPWT)	▪ Insufficient evidence to support the routine use for the management of arterial ulcers[168-169] ▪ Limited evidence has been obtained to recommend that NPWT may be safe to use on arterial ulcers; conclusions about other outcomes were not made.[170] ▪ Frequent reassessment should be conducted to ensure ongoing appropriateness and safety of the therapy for a PAD/LEAD-related ulcer.[168-170]
Spinal cord stimulation (SCS)	▪ Study for the treatment of arterial ulcers is in its early stages.[9] ▪ Stem cell/gene therapy is not recommended for patients with CLTI.[9]
Topical oxygen therapy	▪ Limited evidence to recommend the use of topical oxygen therapy to augment the healing of arterial ulcers. Further study is warranted to make any conclusions regarding its routine use.[60]
Ultrasound therapy	▪ No research currently available to recommend the routine use of therapeutic ultrasound to augment the healing of arterial ulcers[171] ▪ One limited RCT concluded that ultrasound therapy (MIST therapy) had a significantly higher rate of healing at 12 weeks specifically for ischemic (arterial ulcers).[171]

to use a particular advanced therapy. It is important to remember that although advanced therapies may support the healing of arterial ulcers, they do not correct the underlying disease. Whenever possible, adequate blood flow should be restored to sustain the healing unless otherwise contraindicated.[60] When combined with revascularization, the employment of advanced therapies may improve wound-healing outcomes.[60]

Compression and Arterial Ulcers

There is limited evidence to recommend the cautious use of compression therapy to benefit the healing of ulcers that have been assessed to have mixed etiology (arterial and venous). In such cases, the presence of lower extremity edema is considered to be a barrier to wound healing.[12] When advanced LEAD is suspected, a decision to use compression is contraindicated until safe parameters can be determined for the patient, in collaboration with a vascular specialist. Accurate blood flow measures should be determined through appropriate investigations prior to applying compression. A lower level of compression may be appropriate for patients who have a documented ABPI > 0.50 to < 0.80, but should be avoided for those with an ABPI measure < 0.50.[62]

Compression at higher levels may be appropriately used to manage lower limb edema after a successful revascularization procedure has been performed to restore adequate blood flow to the affected extremity.[62] In addition, the prescribing of a lower level compression (18–30 mmHg) should be considered after lower extremity bypass surgery to manage edema.[62] For further guidance on various types and indications for advance therapies refer to Best Practice Recommendations for the Prevention and Management of Wounds.[21]

4.4 Engage the team to ensure consistent implementation of the plan of care.

A person who has been diagnosed with an arterial ulcer is living with a progressive chronic disease. Engaging the entire team, including the patient and their care partners, is an essential part of preventative care and chronic disease management. Professional health-care team members who participate in plans of care for patients with LEAD should be actively engaged in educational strategies that teach and promote

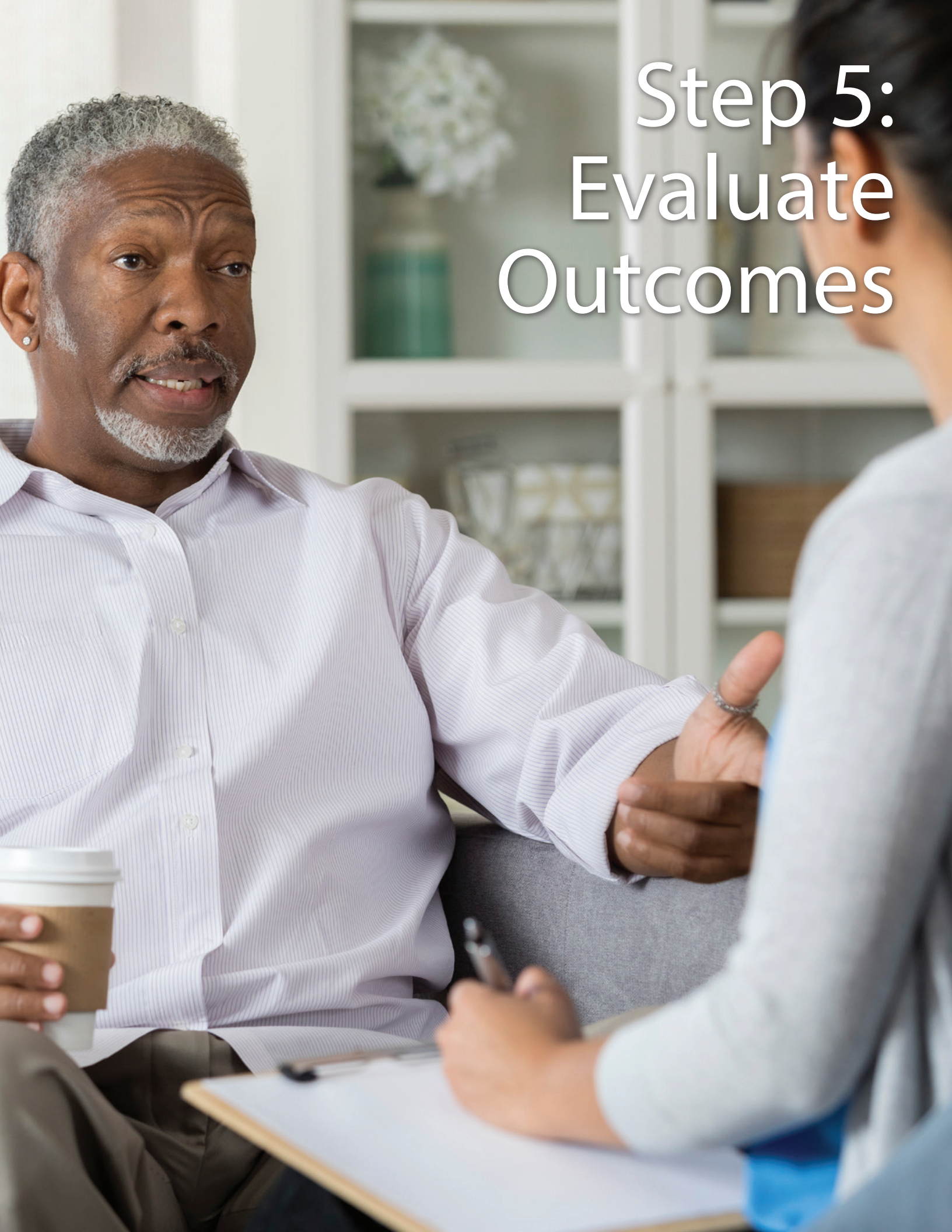
the prevention of ulceration, infection and amputation. Properly determining the goal of care between healing or infection control of the arterial wound is crucial. There is strong evidence to recommend the use of clinical pathways (structured multidisciplinary care plans) by health teams to optimize clinical outcomes, including a reduction in length of hospital stays, reduced in-hospital complications and costs.[172] For further guidance on engaging the team for better patient outcomes refer to Best Practice Recommendations for the Prevention and Management of Diabetic Foot Ulcers and Best Practice Recommendations for the Prevention and Management of Wounds.[21,122]

Table 14 provides a summary of the principle considerations when creating a plan of care based on LEAD status.

Table 14: Summary of Treatment Plan

LEAD Status	Perfusion	Treatment Plan
Borderline*	Adequate	▪ Treat CV risk factors ▪ Early vascular referral ▪ Offload ulcer site and manage PI risk ▪ Cautious moist wound care
Post revascularization (remains patent)	Adequate	▪ Treat CV risk factors ▪ Monitor for re-stenosis (surveillance) ▪ Offload ulcer site and manage PI risk ▪ Cautious moist wound care
Post revascularization (re-stenosis)	Inadequate	▪ Treat CV risk factors ▪ Refer for vascular assessment ▪ Manage ischemic pain ▪ Offload ulcer site and manage PI risk ▪ Monitor vigilantly for infection ▪ Avoid moist wound healing ▪ Keep ulcer clean and dry with antiseptic ▪ Consider adjunctive therapies
Pending revascularization	Inadequate	▪ Avoid moist wound healing ▪ Keep clean and dry with antiseptic ▪ Offload ulcer site and manage PI risk ▪ Manage ischemic pain ▪ Treat CV risk factors ▪ Consider adjunctive therapies
Not a candidate for revascularization	Inadequate	▪ Treat CV risk factors ▪ Monitor for increasing symptoms ▪ Manage ischemic pain ▪ Offload site and manage PI risk ▪ Monitor vigilantly for infection ▪ Avoid moist wound healing ▪ Keep ulcer clean and dry with antiseptic ▪ Consider advanced therapies
Undetermined		▪ Treat CV risk factors ▪ Refer for vascular assessment

* Borderline *here refers to a patient with just enough blood flow for healing; this assessment is difficult to make and should be part of the expert opinion judging healability of the wound based on the presence of adequate perfusion to heal even with impaired circulation.*



Step 5: Evaluate Outcomes

Step 5: Evaluate Outcomes

Recommendations

5.1 Determine if the outcomes have met the goals of care.

Regular evaluation of patient outcomes is an important aspect of care to determine whether the goals of care are being met. This should be an ongoing process carried out collaboratively with the patient and other members of the health-care team to ensure the goals of care are clearly understood and shared. When patients with arterial ulcers undergo treatment for LEAD, the goals of care may need to be modified, depending on the patient's response to treatment. The healability of the ulcer and the overall condition of the patient may change depending on the status of peripheral arterial blood flow and the effects of other comorbidities and other external modalities. In cases of CLTI, achieving and sustaining optimal perfusion to the affected extremity through revascularization will significantly impact whether the goals of care are being met. When the original goals of care no longer seem achievable, setting new goals is an important step in supporting the patient's challenges in addressing the physical, psychological and emotional burden associated with the presence of LEAD. A conservative approach can be the best option at the terminal stage of CLTI. Patient-directed care that reflects a tailored approach is therefore essential.

5.2 Reassess patient, wound, environment and system if goals are partially met or unmet.

When mutually agreed upon goals are not met through the process of arterial wound management, the team must return to Step 1 and reassess the factors that may be impacting the achievement of these goals. Careful attention should be made to any change in wound and vascular status, the degree and/or type of pain or progression of comorbidities and socio-economic changes in a patient's life that may increase stress and impact their ability to participate in any treatment plan.[12]

5.3 Ensure sustainability to support prevention and reduce risk of arterial ulcer recurrence.

Ensuring access to ongoing vascular risk screening, foot care and primary health care will support the management of the associated risks for recurrent ulceration and infection. Clinicians should review the patient's ability to participate in risk factor modification strategies (smoking cessation, medication therapy, appropriate nutrition, exercise programs) and other medical therapies. Current best practice guidelines recommend that both smokers and ex-smokers be asked about smoking status at every visit with a health-care team member.[58] In addition, it is important to measure changes in the patient's overall condition and functional status in response to a therapeutic plan.

Sustaining adequate blood flow in the lower extremity in patients with LEAD is essential for managing the ongoing risk of arterial ulcers, infection, gangrene and amputation.

Because there is a high incidence of re-stenosis when PAD is present, it is recommended that patients who have a prior history of CLTI, or have had a successful revascularization procedure, have scheduled follow-ups with a vascular specialist at

least twice a year, or whenever wound progress stalls or deteriorates.[58] In addition, repeating blood flow measurements regularly is recommended after revascularization procedures to ensure ongoing patency of the vessel.[58] Yearly ABPI or TBPI testing may be valuable in providing a measure of disease progression.[45] Patient education, in the form of both verbal and written instructions, is recommended to prepare the individual and their care partners on how to detect signs and symptoms of re-stenosis.[58]

Encouraging patients to be advocates for their own health will also ensure ongoing vigilance against recurrence of arterial ulcers. A simple measure of encouraging daily foot and leg inspections can be helpful in detecting early signs of complications associated with LEAD.

Conclusion

The presence of arterial ulcers in the lower extremities can result in serious complications, including ongoing infection, gangrene, amputation and death. Prevention of arterial ulcers and timely treatment of the underlying insufficiency in blood flow are essential.

The goal of arterial wound care is not always to heal, but to protect from infection until arterial revascularization is achieved, if possible.[26]

When blood flow cannot be adequately restored, aggressive preventative and management strategies must be employed.

Managing the underlying disease process and employing preventative measures to optimize function and ensure the patient's ability to carry out activities of daily living are critical. Reducing the recurrence of ulcers has been shown to reduce hospital admissions, the costs associated with treatment for wound infection, and community-based home visits, as well as having a significant impact on health-related quality of life.[172-174] Therefore, the development of an integrated team is key in ensuring the patient's goals of care are met and through a comprehensive, evidence-based plan of care.

In conclusion, Best Practice Recommendations for the Prevention and Management of Peripheral Arterial Ulcers is intended to be a review of the most current best practice guidelines specifically dedicated to the prevention and management of ulcers associated with PAD/LEAD. Currently, too few guidelines exist on this topic. This BPR was written to support health-care professionals in the development and implementation of plans of care that can optimize the prevention and management of arterial wounds and minimize unnecessary limb loss through collaboration by integrated teams.

Appendix A
Guidelines and Consensus Documents

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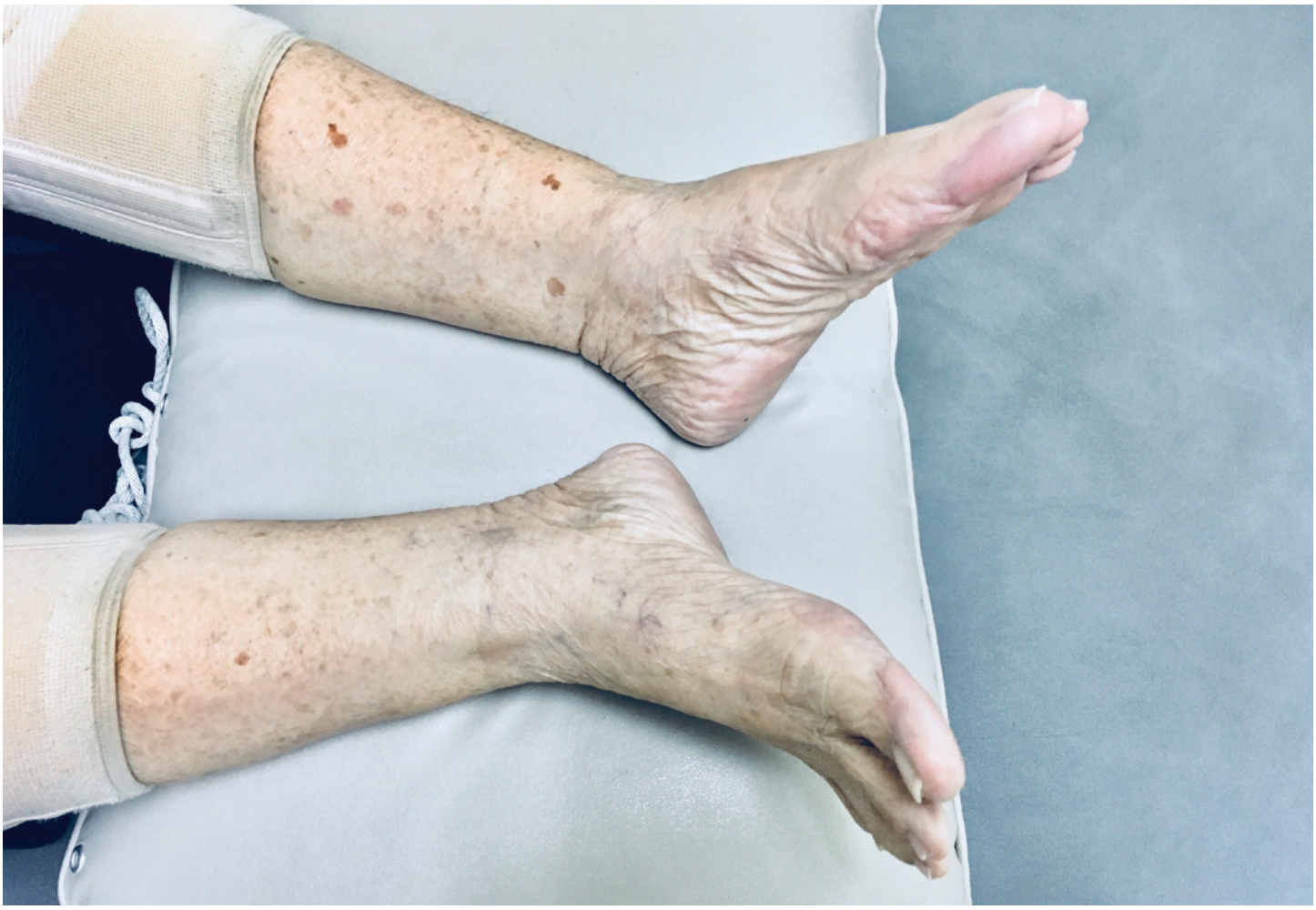

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Appendix B
Levels of Evidence

The most current best practice guidelines (BPGs) are internationally sourced, and the levels and evidence are described using different classification systems. For this reason, the writers of this BPR are including the classification systems currently used to translate levels of evidence by the European Society of Cardiology, as well as the American College of Cardiology.[46,175]

Table 1: European Society of Cardiology Levels of Evidence III[46]

Level A	▪ Data derived from multiple randomized clinical trials or meta-analysis
Level B	▪ Data derived from a single randomized clinical trial or large non-randomized studies
Level C	▪ Consensus of opinion of the experts and/or small studies, retrospective studies, registries
Class I	▪ Evidence and/or general agreement that a given treatment or procedure is beneficial, useful, effective ▪ Recommended
Class II	▪ Conflicting evidence and/or divergence of opinion about the usefulness/efficacy of the given treatment or procedure
Class IIa	▪ Weight of evidence/opinion is in favour of usefulness/efficacy ▪ Should be considered
Class IIb	▪ Evidence obtained from well-designed non-experimental descriptive studies, such as comparative studies, correlation studies and case studies ▪ Usefulness is well established by evidence/opinion ▪ May be considered
Class III	▪ Evidence or general agreement that the given treatment or procedure is NOT useful/effective, and in some cases may be harmful ▪ Is NOT to be recommended

Table 2: American College of Cardiology Levels of Evidence II[175]

A	▪ Evidence obtained from multiple randomized controlled trials (RCT) or meta-analysis ▪ Multiple populations evaluated
B	▪ Evidence obtained from a single RCT or non-randomized studies ▪ Limited populations evaluated
C	▪ Only consensus opinion of experts, case studies, or standard of care ▪ Very limited populations evaluated
Class I	▪ Benefit >>> Risk
Class IIa	▪ Benefit >> Risk
Class IIb	▪ Benefit > Risk
Class III	▪ No benefit, or potential harm

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