Multidisciplinary Approach to PAD: Who's on Your Team?

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Abstract

Keywords

- ▶ peripheral arterial disease
- ▶ critical limb ischemia
- ▶ interventional radiology
- ▶ vascular disease

The complexity of peripheral arterial disease (PAD) and its multiorgan involvement requires the utilization of a multispecialty team approach. Members of this team include a vascular specialty (interventional radiology, cardiology, and vascular surgery), podiatry, orthopedic surgery, primary care, infectious disease, endocrinology, plastic surgery, wound care nursing, and dietetics. A team approach has been proven to significantly improve patient outcomes as well as decreasing amputation rates. In order to promote collaboration and avoid duplication of care, the team can be broken down into three main pillars: medical management, wound care, and revascularization. A complete team approach is vital for this population, with an overall goal to treat all manifestations of the disease and prevent further progression and risk of major sequelae of the disease.

Objectives: Upon completion of this article, the reader will be able to describe the need for coordinated multidisciplinary care in the treatment of patients with peripheral arterial disease and critical limb ischemia

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Peripheral arterial disease (PAD) is defined as atherosclerosis of the arteries, which results in vascular narrowing or occlusion, limiting blood supply to organs outside of the heart.¹ As the disease progresses, there is irreversible damage to nerves and tissues, causing poorly healing

wounds, otherwise known as critical limb ischemia (CLI). Ultimately, these wounds can worsen into tissue gangrene, requiring amputation to prevent systemic infection.

Diabetes mellitus (DM) is the most common medical condition associated with PAD, and its prevalence is rapidly increasing, now affecting over 425 million people worldwide and up to 629 million people by 2045.² Approximately 25% of patients with DM will suffer from a diabetic foot ulcer (DFU) in their lifetime, due to poorly controlled PAD.^{3,4} Since atherosclerosis does not only target the arteries of the extremities, PAD is a marker of diffuse disease, involving all other vital vascular beds including the heart and brain. Therefore, patients suffering from PAD have an extraordinarily high rate of cardiovascular and cerebrovascular events, resulting in a 22% mortality in less than 5 years.⁵ Survival in a patient with CLI leading to major amputations is less than 40% at 5 years, lower than that of heart failure, stroke, and most cancers.^{6,7} Not only are amputations associated with a high mortality, these devastating procedures result in profound physical, psychological, and disabling implications, as well as huge health care resource utilization.⁸ Major amputations can be avoided with prompt identification and treatment of the PAD population.

Identifying patients with PAD and/or CLI is akin to viewing only the tip of the iceberg of their entire medical condition. Given the complexity of the disease and its multiorgan involvement, successful treatment requires the utilization of a multispecialty team approach. Members of this team include a vascular specialty (interventional radiology, cardiology, and vascular surgery), podiatry, orthopedic surgery, primary care, infectious disease, endocrinology, plastic surgery, wound care nursing, and dietetics. Many consensus studies, including guidelines from the Society of Vascular Surgery and the American Podiatric Medical Association, have shown that a team approach significantly improves the PAD patient's outcome and decreases amputation rates.^{9–13} Ideally, each of these specialists should be involved in every patient with PAD or CLI, but this is a challenge in the current healthcare system. In order to promote collaboration and avoid duplication of care, the team can be broken down into three main pillars: medical management, wound care, and revascularization (► **Table 1**). A complete team to treat a patient diagnosed with PAD or CLI should include at least one member from each pillar, with an overall goal to treat all manifestations of the disease and prevent further progression and risk of major amputation, increasing long-term survival (► **Fig. 1**).

Pillar 1: Medical Management

PAD and CLI are extensive diseases that require aggressive management of numerous comorbidities. The members of

the medical management pillar include primary care, infectious disease, endocrinology, cardiology, and dietetics.

There are numerous risk factors associated with PAD: hyperlipidemia, hypertension, diabetes, renal failure, smoking, obesity, and family history, among many others.¹⁴ Of these, diabetes serves as one of the biggest contributors, resulting in the highest level of below-the-knee atherosclerotic occlusive disease. This is opposed to smoking, which characteristically results in atherosclerosis of more proximal vessels. Distal disease is more frequently associated with a higher risk of tissue loss and gangrene, giving rise to the high rate of DFUs.^{15,16} Several mechanisms of action have been discussed in detail, ranging from vascular inflammation, endothelial cell dysfunction, abnormal blood and smooth muscle cells, and abnormal hemostasis, all of which are accelerated with lack of glycemic control.^{1,14–16} In addition, worse clinical outcomes from wound treatment are associated with lack of medical control of these conditions.

Once a patient is diagnosed with PAD or CLI, medical management always begins with lifestyle modifications to prevent or delay the progression of the disease. Some important modifications are cessation of smoking, weight loss, exercise, and education.^{1,17–19} Although seemingly small, these modifications can have some of the largest impacts on the patient's overall outcome, and even reverse other underlying medical conditions. Although the burden of lifestyle modification should be stressed by each practitioner involved in the patient's care, key players in this realm

Table 1 Brief summary of key roles of various team members, divided into three pillars: medical management, wound care, and revascularization

<i>Three pillars of the PAD team</i>	
Medical management	Key roles
Primary care	Diagnosis of PAD, management of multiple comorbidities, education, referral to other specialties
Cardiology	Diagnosis of PAD, management of cardiac comorbidities, education
Endocrinology	Management of diabetes and other diabetic-related conditions
Infectious disease	Optimal and tailored antibiotic regimens for active infections in a foot ulcer
Dietetics	Provide diabetic education and improve nutrition and diet
Wound care	
Podiatry	Diagnosis of foot ulcers/PAD, comprehensive diabetic foot care (medical and surgical), prevention, foot care, routine surveillance, wound healing
Vascular surgery	Diabetic foot care (medical and surgical), wound healing
Wound care nursing	Routine follow-up for prevention and treatment
Orthopedic surgery	Diabetic foot care (surgical), primarily distal amputations
Plastic surgery	Diabetic foot care (surgical), including complex wound closure techniques
Revascularization	
Interventional radiology	Vascular workup, including providing and interpreting extensive noninvasive studies, diagnostic angiography, and endovascular intervention
Interventional cardiology	Diagnostic angiography and endovascular intervention
Vascular surgery	Diagnostic angiography, endovascular intervention, and surgical bypass

Note: The roles of the specialists are not limited to the three pillars, and there is significant overlap between the pillars.
Abbreviation: PAD, peripheral arterial disease.

Fig. 1 The three pillars of the peripheral arterial disease (PAD) team. There is significant overlap across all pillars and the center of the overlap constitutes the minimum of a comprehensive team (one member from each) to treat a patient suffering from PAD and/or critical limb ischemia.

include primary physicians, as well as registered nutritionists and dietitians.

The PAD/CLI patient needs aggressive management of underlying medical comorbidities. As noted, diabetes is one of the most common associations and contributors to disease progression. Therefore, effective glucose management by internal medicine subspecialists (i.e., endocrinology) is needed to halt the disease and improve intervention outcomes. A 1% reduction in hemoglobin A1c results in 25% reduction in microvascular complications.²⁰ Concurrently, a 1% increase in hemoglobin A1c results in a 25 to 28% increase in the incidence of PAD.²¹

Claudication and foot wounds are just a tip of the iceberg, with life-altering cardiovascular disease hiding just beneath the diagnosis. A cardiac workup with routine surveillance by cardiology is necessary in the PAD population, especially the CLI patient who will need lifelong invasive procedures. In this patient population, the high rate of life-altering, and even fatal, myocardial infarction and stroke can be reduced with aggressive medical therapy. Effective, evidence-based regimens to reduce major cardiovascular events include high-dose statin, antiplatelet, and antihypertensive therapy.^{15,18,19,22}

In the CLI patient, infection control is also extremely important. An infectious disease specialist can aid with systemic antimicrobial treatment, beginning with empirical therapies which are then tailored to the specific regimens based on culture. Variable bioavailability of several oral and parenteral antibiotics makes management of these DFUs complex, requiring a high level of care and attention to detail. Unfortunately, many CLI patients who do not have an ID

specialist on their team are placed on empirical “standard” antibiotics without a tailored approach, resulting in poor wound control and worsened outcomes.²³

Pillar 2: Wound Care

The wound care pillar of the team is specific to the patient suffering from CLI. These patients suffer from irreversible damage and ulceration primarily due to lack of oxygenated blood supply to the target tissue. In addition to poor perfusion, several additional factors contribute to the development of these wounds, including repetitive trauma, pressure, and abnormal biomechanics.^{11,24,25} Several social considerations, such as living alone and poor hygiene, as well as lack of education can also contribute to disease progression.¹¹

Members of this team include podiatry, wound care nursing, orthopedic, vascular surgery, and plastic surgery. Wound care involves an in-depth knowledge ranging from prevention, biomechanics, wound assessment, medical management, and surgical intervention.^{11,24} Although a variety of strategies are present for treatment of wounds, the primary goal of any PAD patient is the prevention of ulceration, which is the key to limb salvage. Activities such as surveillance, protective footwear and prosthetics, pressure reduction, prophylactic surgery, and preventative education can significantly reduce the incidence and recurrence of ulceration.¹¹ Podiatrists play a key role in all these activities and are essential team members to any patient suffering from PAD or CLI. In fact, patients with diabetes are one-third as likely to undergo amputation when seen regularly by a podiatrist.^{11,24}

Apart from prevention, active wound care involves treating the inciting factor as well as providing a local environment to promote healing and tissue regeneration. A critical component to local healing is frequent debridement, which involves removal of necrotic and infected tissues. Debridement reduces the bacterial load and stimulates growth factors, and can be achieved with a variety of enzymatic, autolytic, mechanical, and surgical methods.^{26,27} Other key regimens of active wound care are offloading (i.e., total contact casting), edema control, dressing changes, antiseptics, and numerous topical regenerative regimens (i.e., hydrocolloids).^{11,13,15,24,25} Wound care nursing and home health are very helpful service providers with these regimens, which require special expertise and are resource intensive.

Comprehensive wound care also includes several adjunctive wound-directed therapies. For example, negative pressure wound therapy (i.e., wound VAC) can reduce healing time and frequency of ulcers by constantly reducing the bacterial load and edema while simultaneously stimulating angiogenesis and cellular proliferation.²⁸ Hyperbaric oxygen therapy is the administration of 100% oxygen at supra-atmospheric pressures to the affected extremity, enhancing perfusion and reducing hypoxia of the local tissues, improving outcomes in patients with DFUs.²⁹ These adjunctive, specialized therapies are typically offered at high-volume wound care centers and are coordinated and streamlined by podiatric services.

Complex wound closure sometimes requires close collaboration between different surgical fields: podiatry, vascular surgery, orthopedic surgery, and plastic surgery. These types of surgeries range from split skin grafting, with utilization of many skin substitutes, to larger surgeries such as Achilles' tendon lengthening to correct underlying biomechanics and vascularized muscle flaps which can heal large defects and cover bone.^{24,30} In addition, the goal of limb salvage is to promote healing and avoid a major amputation (defined as below knee or more proximal). Frequently, a minor or ankle-joint-preserving amputation is required to remove infected tissue and bone. Most common distal amputations include digital, ray, and transmetatarsal amputations. Other ankle-preserving amputations that a treating team member should be familiar with include transphalangeal, Syme, Boyd, talonavicular, and partial calcaneal amputations.

Pillar 3: Revascularization

Restoring blood flow, or revascularization, to the affected tissue is the cornerstone to relieving symptoms in the PAD patient or healing a wound in a CLI patient. There are a wide range of options for revascularization for a patient suffering from symptomatic PAD: endovascular strategies, open surgical bypass, and a combination hybrid approach. Prompt and efficacious treatment is the goal to avoid risk of major amputation. The revascularization pillar of treatment is composed of one or multiple vascular specialists, who can be trained in interventional radiology, cardiology, or vascular surgery. All three specialties share a common expertise in endovascular intervention, although experience with distal occlusive disease and advanced recanalization techniques can significantly

vary depending on training. Vascular surgery provides surgical bypass options to the appropriate candidates.

In a symptomatic patient suffering from PAD, a vascular workup is necessary to determine level and extent of disease. Although a vascular workup has been recommended as a standard of care, over 50% of patients with CLI had no vascular evaluation preceding primary amputation.^{7,31} Widely available noninvasive workups include ankle brachial indices, segmental pressures, duplex ultrasound, computed tomographic angiography, and magnetic resonance angiography. Additional noninvasive information that can supplement the above include plethysmography/pulse volume recordings, transcutaneous oxygen pressures, and skin perfusion pressures.¹⁵ Conventional diagnostic angiography is frequently combined with therapeutic endovascular intervention, when appropriate. A vascular workup can also identify adequate distal targets and conduits for surgical bypass.

Endovascular therapies have significantly evolved and concurrently increased throughout the United States. Common interventions include plain old balloon angioplasty and stenting, but recent advances in atherectomy and drug-coated balloon angioplasty have shown promising results. Recent advances in retrograde tibio pedal access have dramatically increased the technical success of distal and long segment occlusive disease, and more below ankle and pedal loop revascularization is providing increased perfusion to distal tissues previously deemed unsalvageable.^{30,32,33}

Surgical bypass involves creating an autologous or prosthetic conduit from an area of normal arterial inflow to the most proximal artery that is past the critical stenosis or occlusion. The available conduit and position of the distal anastomosis both play a key role in defining durable outcomes and are frequently limiting factors in a CLI patient. The accepted gold standard for surgery is a reversed, nonreversed, or in situ saphenous vein (autologous graft), which have been shown to be the most durable conduit at all levels.³⁴⁻³⁶ In general, the great saphenous vein (GSV) is usually mapped in detail by the vascular surgeon using ultrasound, and ideal veins are soft, compressible, and at least 3 mm in diameter.³⁴ If a suitable GSV is not identified, then other options include spliced arm or leg veins, cryopreserved saphenous vein allografts, and polytetrafluoroethylene (PTFE) grafts. However, the latter options are falling out of favor due to poor outcomes in the setting of below knee targets.^{34,37} It is important to keep in mind that younger surgical trainees also may have a limited scope on complex open surgical bypass due to the increased trend toward endovascular options across all specialties.³⁸

As prompt restoration of blood flow is the purpose of this third pillar, a collaborative approach to a revascularization strategy is paramount for best patient outcome. Currently, there is no clear-cut evidence to favor an endovascular versus surgical revascularization approach. Instead, each patient requires an individualized evaluation to determine the best treatment approach, which relies on patient preference, comorbidities, available veins, distal disease, etc. This decision-making process requires a collegial environment between the vascular specialists, especially in centers where there is

significant overlap for endovascular intervention. Several trials including the First-Line Treatments in Patients With Critical Limb Ischemia (CRITISCH) registry³⁹ and the Bypass versus Angioplasty in Severe Ischemia of the Leg (BASIL)⁴⁰ found no differences in long-term mortality or major amputation when comparing both strategies. The Best Endovascular versus Surgical Therapy in Patients with Critical Limb Ischemia (BEST-CLI) trial is a promising current multicenter, randomized trial that will add evidence and further help guide treatment options for the CLI patient.⁴¹ As of August 2018, the BEST-CLI study enrolled 1,433 out of a goal of 2,100 patients.⁴²

Conclusion

PAD is a complex disease process that requires a collaborative team of several physicians and healthcare providers to prevent major disability and mortality. Due to the vastness of the disease, a three-pillar system to the management of PAD and CLI provides a practical, yet comprehensive approach to the patient suffering from PAD and can significantly decrease the incidence of devastating outcomes. Many “physician extenders,” which include diabetic educators, vascular technologists, schedulers, administrative staff, are also essential to allow the pillars to function. By bringing together the talents of numerous team members, we can remain committed to providing the optimal care and further increase limb salvage.

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