PERSPECTIVES

# Leveraging the Cardiovascular Team in Peripheral Artery Disease Diagnosis: A Call to Action

Craig J Beavers[1], Youssef Bessada [2], Rachel Bond[3], Kristen Veneman[4], Geoffery D Barnes [5]

[1]Department of Pharmacy Practice and Science, University of Kentucky College of Pharmacy, Lexington, KY, USA; [2]Department of Pharmacy Practice, University of Connecticut School of Pharmacy, Storrs, CT, USA; [3]DHMG Dignity Health Medical Group, Gilbert, AZ, USA; [4]Elliot Vascular Surgery, Elliot Hospital, Manchester, NH, USA; [5]Frankel Cardiovascular Center, Department of Internal Medicine, University of Michigan, Ann Arbor, MI, USA

Correspondence: Craig J Beavers, Department of Pharmacy Practice and Science, University of Kentucky College of Pharmacy, 789 South Limestone Street, Lexington, KY, USA, Tel +1 859-983-0393, Email cjbeav2@uky.edu

**Abstract:** Lower extremity peripheral artery disease (PAD) is a common atherosclerotic cardiovascular disease (ASCVD) involving the aortoiliac, femoropopliteal, and infrapopliteal arterial segments. PAD remains a largely underdiagnosed and undertreated condition. The ankle-brachial index (ABI) is a simple and widely available test that is key detection tool in the diagnosis of PAD and is prognostic for mortality and morbidity. The cardiovascular (CV) team is a diverse array of health care clinicians (eg, nurses, nurse practitioners, physician assistants/associates, pharmacists, podiatrists) who have the qualifications and skills to be able to recognize when patients are at risk for PAD and perform an ABI. It is critical that the healthcare community recognize the critical role the CV team could play in improving outcomes and reducing disparities for patients with PAD.

**Keywords:** atherosclerotic cardiovascular disease, team-based care, ankle-brachial index, health disparities

## Introduction

An estimated 8–10 million adults in the United States (US) over 40 years-old are diagnosed with PAD.[1–5] Lower extremity peripheral artery disease (PAD) is a common atherosclerotic cardiovascular disease (ASCVD) involving the aortoiliac, femoropopliteal, and infrapopliteal arterial segments. While several non-atherosclerotic etiologies of PAD exist (eg, vasculitis, entrapment syndrome, cystic adventitial disease), overwhelmingly atherosclerotic PAD is most common. Multi-disciplinary care is a hallmark of PAD management, including both medical and surgical specialties along with the cardiovascular (CV) team (Central Figure). Unfortunately, PAD remains an underdiagnosed and under-treated condition associated with significant morbidity and mortality that could be prevented with early detection and initiation of medical therapies. The aim of this work is to outline and leverage the role of the CV team in the diagnosis of PAD.

## Peripheral Artery Disease Awareness

The ankle-brachial index (ABI) is a simple, noninvasive measure of systolic blood pressures at different levels of the arms and legs in the supine position using a Doppler device and is a key detection tool in the diagnosis of PAD.[6] In a meta-analysis of ~48,000 individuals in the US, an ABI ≤ 0.9 was associated with triple the risk of all-cause death compared with ABIs of 1.11–1.40.[7,8]

The relative morbidity, mortality, and quality of life impact associated with PAD present a significant burden of disease and associated strain on the healthcare system. Unfortunately, population- and clinician-level awareness of PAD, associated complications, and optimal medical therapy (eg, antiplatelet, statin) remain historically low.[1,9–12] Surveys of primary care practices have demonstrated low identification of PAD despite low ABI results.[9,12] This results in less use of optimal medical therapy and involvement of the CV team, despite guidelines demonstrating improved outcomes with

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early medical optimization.[6] As a result, patients often adjust their lifestyle to avoid or manage symptoms, in comparison to coronary artery disease.[11]

## PAD Amongst High-Risk Populations

Guidelines recommend ABI testing to establish the diagnosis of PAD in patients with history of physical exam findings suggestive of PAD. This includes patients with claudication, nonjoint-related exertional lower extremity symptoms, ischemic rest pain, history of lower extremity ulcers, or erectile dysfunction.

PAD prevalence is similar between sexes. However, an aging population whose life expectancy is longer in women as compared to men, the burden of disease disproportionately impacts women in the US aged ≥40. When women experience PAD, they are more likely to have atypical symptoms and less likely to have ideal cardiovascular health. As a result, they experience worse outcomes even after revascularization, likely because of delayed diagnosis and undertreatment of medical risk factors.[13]

Health disparities or preventable differences are also noted by one's race and ethnicity. Non-Hispanic Black adults have the greatest risk of PAD while Hispanic adults have the same, if not slightly lower, rate of PAD compared with their non-Hispanic White counterparts. This similar-to-lower rate of PAD among Hispanic adults is somewhat counterintuitive given the higher prevalence of risk factors that lead to PAD, particularly diabetes.[1] First and foremost, it is important to highlight that the concept of race and ethnicity is a social construct, not rooted in biology, and but governed by inequities in society as a factor of the social determinants of health (SDOH).[14] Therefore, excess PAD prevalence among Black people cannot be explained by traditional risk factors alone. As Black Americans, they are not only more likely to have PAD than other racial and ethnic groups, but tend to present with more severe disease, have more atypical symptoms, and are more likely to suffer worse outcomes. Specifically, they less often undergo limb salvage therapy and more often are referred for limb amputation and thus are more likely to die from major CV events.[14,15]

## Detection and Diagnosis

PAD is often asymptomatic in mild cases, becoming more symptomatic with progression to moderate or severe. Through a careful history and physical (H&P) examination, signs and symptoms of PAD can be detected as well as risk factors outlined in the guidelines (Table 1).[6]

After the H&P exam, diagnostic studies can be ordered to provide quantifiable evidence of PAD. Arterial physiologic testing is a great tool to aid the diagnosis, providing a clear objective evaluation. Testing is also useful in the determination of the extent of arterial disease (Table 2).[16]

**Table 1** Pertinent Questions When Detecting for Peripheral Artery Disease

| |
|---|
| Common symptoms associated with PAD include lower extremity pain, claudication, weakness, nonhealing wounds or ulcers, and neurosensory complaints such as numbness and tingling. Claudication is defined as pain within a defined muscle group that is induced by exercise and relieved with rest and can be diffuse (eg in hip, thigh, calf, and foot). In more severe cases, patients may also experience ischemic rest pain.[16] Symptoms vary based on several factors including degree of arterial narrowing, number of affected arteries, and level of activity of the patient.[16] Importantly, many patients present with asymptomatic disease or atypical symptoms. |
| • Does the patient have any pain with ambulation? |
| ○ If so, how far can the patient walk before the pain occurs? |
| • Does the pain cause the patient to stop walking? |
| ○ If so, after how much time is the patient able to resume walking? |
| • Does the pain recur after a similar walking distance? |

(*Continued*)

**Table 1** (Continued).

| |
| --- |
| • Has the patient's ability to walk diminished over time or altered the patient's lifestyle in any way? |
| • Does the patient experience any pain in the extremity that wakens them from sleep? |
| ○ If so, where is the pain located? |
| • Is the pain relieved once the foot is hung over the side of the bed? |
| • Does pain cause the patient to sleep sitting in a chair? |
| • Has the patient noticed any nonhealing wounds or ulcers (deep, "punch-out", circular wounds that appear pale or necrotic) on the toes? |
| ○ If so, how long have the wounds or ulcers been present? |
| • If wounds have occurred in the past, what measures were used to promote healing? |
| • Is skin discoloration or hair-loss on the lower limb present? |

**Table 2** Peripheral Artery Disease Testing Modalities[6,16–22]

| Test | Indication | Benefits | Limitations |
| --- | --- | --- | --- |
| Ankle Brachial Index (bedside/ without treadmill) | An ABI is the most common test performed to establish diagnosis in patients with history or physical examination findings consistent with PAD. | An ABI is a reliable, non-invasive, and widely used test that can be done either at the bedside or in a vascular lab. ABI has a high degree of sensitivity and specificity for PAD. | Some patients with severe PAD or painful wounds may not be able to tolerate the pressure cuffs. A resting ABI also does not always correlate well with physical symptoms and may not detect non-obstructive atherosclerotic lesions. Patients with calcified blood vessels (especially small vessels) can give abnormally high or unreadable results. |
| ABI with Treadmill/ Exercise Testing | Exercise testing is a reliable method for diagnosing PAD in patients with classic symptoms of claudication but found to have a normal resting ABI. | Exercise testing is very beneficial for distinguishing between arterial occlusive disease and neurological conditions such as spinal stenosis. The exercise test additional provides objective evidence of the functional limitations of patients with claudication. | This test needs to be done in a vascular lab with a treadmill. Patients must be able to walk on the treadmill for this exam. Patients should not have critical cardiovascular disease (eg, severe aortic stenosis, acute coronary syndrome). |
| Six-minute walk assessment | The six-minute walking test is indicated to quantify the speed and duration of ambulation to quantify the degree of claudication. It is not a screening tool. | This test does not require any equipment and is a great way to get a baseline assessment of claudication symptoms by measuring time of onset of pain, recovery of pain, and location of pain. It is a good alternative to Exercise Testing when a treadmill is not available. | This test is not as reliable as an ABI or Exercise Test because it does not provide objective data regarding circulation. Can easily be limited by other medical comorbidities such as cardiac/ respiratory or musculoskeletal issues. |
| Audible Handheld Doppler Ultrasound | Non-palpable pedal pulse; pedal edema | A doppler assessment is a quick and easy exam to detect blood flow to lower extremity. It can be done at the bedside or during a clinic visit. | Operator variation /skill level; blood pressure dependent |
| Ultrasound/ Arterial duplex | Abnormal ABI or ongoing surveillance after intervention. | An arterial duplex is a diagnostic study often used in conjunction with an ABI to identify location and severity of arterial disease. This exam provides a visual of plaque morphology, as well as speed and flow of blood in arterial vessels. | Greater margin of error than a CTA or MRA. |
| CTA | Computed tomography angiography (CTA) is recommended for further evaluation of anatomic location and severity of stenosis in patients who are expected to undergo revascularization. | A CTA is a diagnostic exam that provides a high-resolution image of arterial vessels which is often used for surgical planning. CTA is more commonly used than MRA because it is more widely available, cheaper, and quicker. | This exam is reserved for highly symptomatic patients. It requires the use of iodinated contrast media which is nephrotoxic and a potential allergen. Not recommended for patient with kidney disease |
| MRA | Magnetic resonance angiography (MRA)is a widely used modality for imaging of peripheral artery occlusion diseases | This diagnostic exam provides evaluation of blood flow and structure of peripheral arteries. This can be done with or without contrast. This is a good alternative exam for patients with renal disease or patients with severe allergy to contrast dye. | This exam is not used as often, compared to CTA, due to factors of scanner availability, higher costs, patient tolerability, and incompatibility with certain metallic implants. This exam may have difficulty with imaging high grade stenosis. If the exam is not done properly there is a high likelihood for native artery stenosis to be overestimated. |

(*Continued*)

**Table 2** (Continued).

| Test | Indication | Benefits | Limitations |
|------|-----------|----------|-------------|
| Catheter Angiography/ Angiogram | Invasive procedure done to locate areas of high-grade stenosis for which revascularization is recommended. CTA or MRA are indicative of significant stenosis impacting lower extremity circulation. | An angiogram is a minimally invasive diagnostic procedure that can accurately identify specific areas of stenosis. Providers are often able to perform intervention while performing this exam. They can locate the exact areas of stenosis and then proceed with angioplasty, atherectomy, or stenting. | Invasive exam with greater risk of harm to patient. Requires contrast media, which is nephrotoxic. |

# Cardiovascular Team in Disease State Management

A key strategy in addressing health inequity related to PAD detection is engagement of the CV team (Table 3).[23,24] Within the realm of PAD, multiple members of the team are capable to assist in PAD diagnosis.[6,19,23–31] Specifically, the American Heart Association (AHA) states that ABI testing should be performed by qualified individuals through the following principles.1) Measurement and interpretation of the ABI should be within standard curriculum for medical and nursing students, and 2) all allied health professionals, beyond nursing and physicians, who perform the ABI should have didactic and experiential learning under a qualified healthcare professional to perform the ABI.[32] In the team-based model, having multiple members of the team who can perform or recommend an ABI, throughout the care continuum, expands accessibility for PAD detection with potential to increase diagnosis and management.

The role of the CV team in PAD diagnosis, with a focus on recommending, ordering, and interpreting ABI testing, can occur in three settings: 1) inpatient 2) outpatient 3) community (Figure 1). In terms of inpatient, all members of the CV team should assess patients for PAD risk to determine the need for diagnostic testing and/or follow-up as outlined in the ACC/AHA guideline on the management of lower extremity of PAD.[6,17] Patients admitted to the hospital are seen by various members of the CV team who have the capability of performing an assessment and coordinating follow-up including allied professionals with a specialized training to assist with assessment, diagnosis, and transition of care management. Advanced practice clinicians bring a high-level, advanced CV skills in accordance

**Table 3** The Various Roles of the Cardiovascular Team in the Detection & Diagnosis of Peripheral Artery Disease

| | Nurses / Nurse Practitioners | Pharmacists | Wound Care Specialist / Podiatrists / Exercise Physiologists | Physicians / Physician Assistants |
|---|---|---|---|---|
| **Training & Specializations** | • Symptomatic assessment expert<br>• Advanced practice training in vascular medicine allows for highly skilled management of PAD patients | • Medication expert<br>• Specialization in cardiovascular pharmacy allows for inpatient and outpatient specialized medication management | • Physical assessment expert<br>• Highly specialized team with focus the lower extremity monitoring, disease progression and recovery | • Diagnostic expert<br>• Specialization in vascular medicine and surgery allow for specialized care of PAD patients |
| **Accessibility** | Front-line personnel in the admission process of the inpatient and outpatient setting | Most-accessible clinician in community setting | Valuable support in both the healthcare and non-healthcare community setting | Care-providers in the inpatient and outpatient setting |
| **Role on the CV Team in PAD Management** | • Vascular trained nurses are highly specialized in the assessment of common symptoms of PAD, claudication and ischemic rest pain<br>• Key to recommending ABI and further testing upon admission symptom evaluation | • Experts in the association of medications with signs, and presentation of atherosclerotic disease<br>• Front-line clinical team in the detecting and triaging lower-extremity related symptoms vs OTC self-care | • Clinicians most-closely associated with lower-extremity disease prevention and therapy<br>• Key members in the reporting of worsening lower extremity symptoms and disease progression | • Key diagnostic experts in the differentiation of PAD from the presentation of other extremity disease states<br>• Order, interpret and recommend ABI testing and various forms of imaging secondary to ABIs |
| **Rutherford Stage Involvement for Detection** | 1–6 | 0–4 | 2–6 | 0–6 |

**Notes**: Rutherford Staging (0 = Asymptomatic, 1 = Mild Claudication, 2 = Moderate Claudication, 3 = Severe Claudication, 4 = Rest Pain, 5 = Ischemic Ulcer of Digits of Foot, 6 = Severe Ischemic Ulcers of Gangrene).
**Abbreviations**: PAD, Peripheral Artery Disease; ABI, Ankle-Brachial Index; OTC, Over-The-Counter (medications).
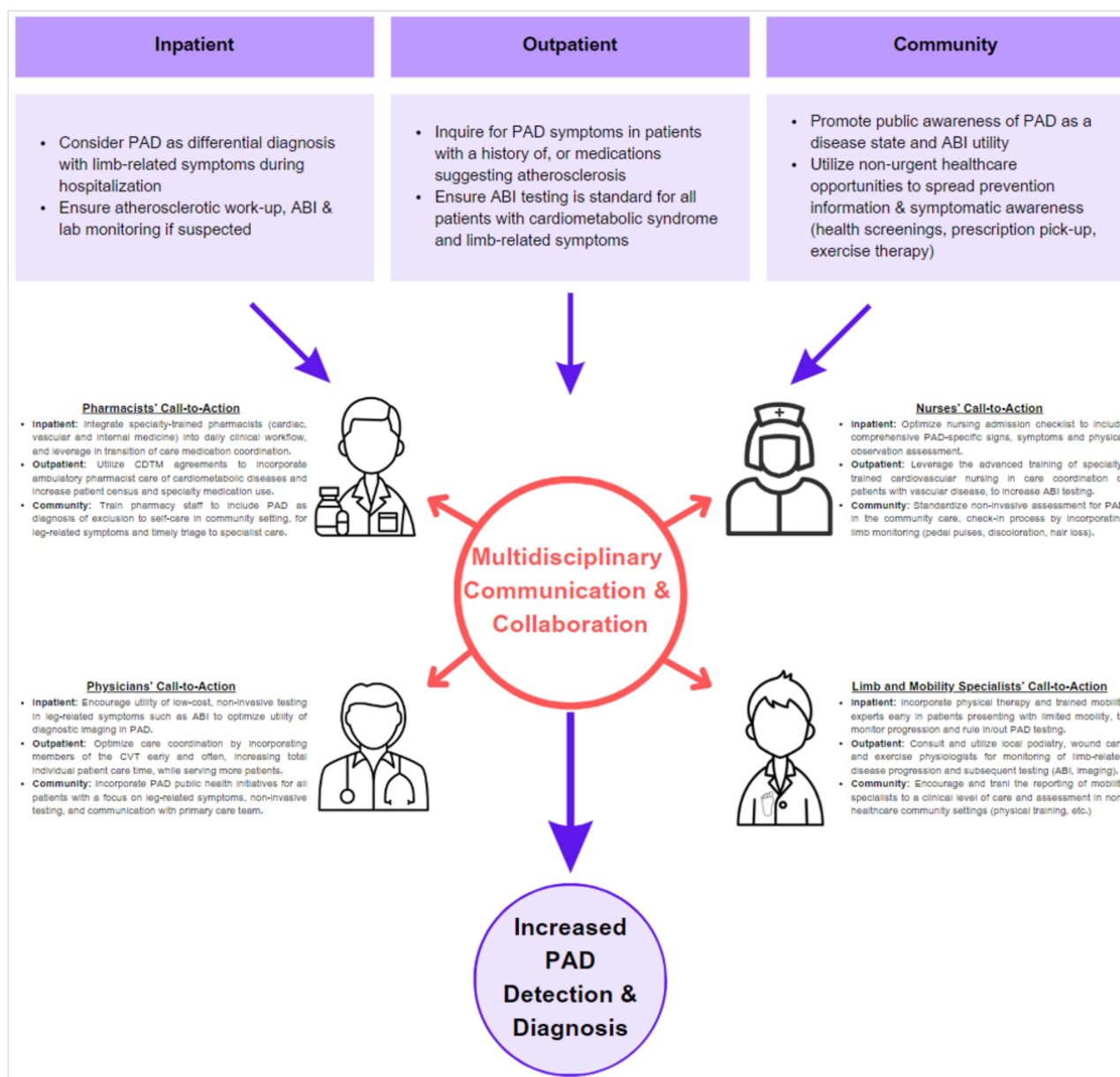
**Figure 1** The Collaboration of Cardiovascular Team Members for Peripheral Artery Disease Management at Each Phase of Care.

with the minimum competencies set by CV organizations.[29] Pharmacists within these CV specialties obtain postgraduate specialty residency accreditation, board certification, and provide direct care through comprehensive medication management.[31]

In the outpatient setting, there are a multitude of clinicians in various locations that should be engaged in PAD assessment and ABI testing. A policy for CV team involvement in PAD diagnosis should include outlining the assurance of competency, outlining roles and expectations, and process for ordering specific testing or collaborative management protocols (recommending supervised exercise therapy, initiating pharmacotherapy, tobacco cessation).[29,31] Beyond the traditional clinic space, there are numerous other sites with CV team members that should be engaged in PAD detection and diagnosis. Often patients who are referred to wound care clinics may have foot-related ulcer and undiagnosed PAD.[19] Exercise physiologists are engaged with patients enrolled in workout programs.[19] In these programs and clinics, signs and symptoms of PAD are noticed and ABI testing ordered. Lastly, an even more underutilized resource are pharmacists who exist both in clinics and community-based pharmacies. Pharmacists, one of the most accessible healthcare clinicians,

are in a unique position to increase detection and implement treatment for PAD.[33] The training of these accessible professionals to identify PAD symptoms and risk factors, and then mitigate ABI referrals has been proven to be effective and should be expanded upon.[33] CV team members offer an effective and cost-conscious approach to improving PAD diagnosis and treatment for this highly morbid and under-treated condition.

Lastly, all members of the CVT should be engaged in community outreach. When healthcare access is improved for patients within their own communities, diagnosis and management improves.[34,35] Having trained, competent-based healthcare clinics working with trusted members of varying communities to provide detection should be best practice. CV team members should be instrumental in increasing access to ABI testing in a wide range of clinical settings.

While the importance of having a diverse array of clinicians who are competent in detection and/or diagnosis, the additional benefit of CV team engagement in the management of PAD should be acknowledged. Within the cardiovascular realm, there are exhaustive examples of how team-based care improves outcomes, patient satisfaction, and reduces clinician burnout.[25] The utility of the various CV team members' knowledge base may allow for better navigation through resources for patients to obtain treatment, address barriers, and provide detailed education. As such, the detection, identification, and management of PAD patients should be incorporated early into the various healthcare curricular programs.

## Conclusion

CV team members could improve the diagnosis and medical management of PAD patients. Given the heterogeneous nature of CV team roles, specific opportunities to improve PAD diagnosis and treatment will differ between clinician and within each system. Nonetheless, we should empower CV team members to 1) recognize patients with risk factors, signs, and symptoms of PAD; 2) facilitate early diagnostic testing for PAD; and 3) discuss appropriate medical management with their clinical colleagues. PAD awareness, detection and management should be an emphasis in the training of all CV team members. For vulnerable populations to underdiagnosis and undertreatment, leveraging each CV team member to assist with diagnosis and medical management of PAD is paramount.

## Society Endorsements

The following organizations have reviewed and endorsed this document, recognizing the critical role of the cardiovascular team in peripheral artery disease detection and diagnosis. Furthermore, they believe that the involvement of multidisciplinary CV team members including nurses, pharmacists, and advanced practice providers will lead to improved outcomes and reduced disparities for patients with PAD:

American Association of Colleges of Pharmacy

American College of Cardiology Cardiovascular Team Section

American College of Clinical Pharmacy Cardiology Practice and Research Network

Anticoagulation Forum

Society for Vascular Medicine

Society for Vascular Nursing.

## Disclosure

Dr Barnes provides consulting for Pfizer, Bristol-Meyers Squibb, Janssen, Bayer, Boston Scientific, AstraZeneca, Sanofi, Anthos, Abbot Vascular and serves on the Board of Directors of the Anticoagulation Forum. The remaining authors report no conflicts of interest in this work.

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