Editor’s Note: This Special Communication is part of a collection of articles commemorating the APMA-SVS alliance. Companion papers can be read at https://doi.org/10.7547/20-137, https://doi.org/10.7547/20-217, https://doi.org/10.7547/20-165, and https://doi.org/10.7547/19-175.
SPECIAL COMMUNICATION

The Significance of the Global Vascular Guidelines for Podiatrists: Answers to Key Questions in the Diagnosis and Management of the Threatened Limb

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The publication of the Global Vascular Guidelines in 2019 provide evidence-based, best practice recommendations on the diagnosis and treatment of chronic limb-threatening ischemia (CLTI). Certainly, the multidisciplinary team, and more specifically one with collaborating podiatrists and vascular specialists, has been shown to be highly effective at improving the outcomes of
This Special Communication has been reviewed, accepted for publication, and approved by the author. It has not been copyedited, proofread, or typeset and is not a final version.

limbs at risk for amputation. This article uses the Guidelines to answer key questions for podiatrists who are caring for the patient with CLTI.

The Society for Vascular Surgery, the European Society for Vascular Surgery, and the World Federation of Vascular Societies published the Clinical Practice Guideline Document titled, “Global vascular guidelines on the management of chronic limb-threatening ischemia.”¹ The document is the product of collaboration of 58 key opinion leaders from 24 countries to review the evidence and present best practices for occlusive arterial diseases of the lower extremities and their treatments. The authors used the GRADE method to determine the quality of the evidence and the strength of the corresponding recommendations.² The Guidelines were endorsed by the American Podiatric Medical Association in 2019.

Overall, the Global Vascular Guidelines are a 163-page document using, when possible, evidence-based revascularization to address the essential components in the care of the ischemic limb. The Guidelines broadly cover all aspects of the care of the patient with lower limb ischemia and the document is available open access in the Journal of Vascular Surgery. We extracted the concepts most pertinent to the podiatric care of the ischemic limb and put them into the form of key questions and answers.

“Certainly, the multidisciplinary team, and more specifically one with collaborating podiatrists and vascular specialists, has been shown to be highly effective at improving the outcomes of limbs at risk for amputation”
What is the Definition of Chronic Limb-Threatening Ischemia (CLTI)?

The Guidelines establish a terminology change and preference away from the term critical limb ischemia (CLI) toward chronic limb-threatening ischemia (CLTI) because CLI implies that there are minimum threshold values for impaired perfusion and CLTI recognizes that the impaired perfusion occurs on a continuum. CLTI is a clinical syndrome and more severe stage of peripheral artery disease (PAD) defined by the presence of PAD in combination with rest pain, gangrene, or a lower limb ulceration >2 weeks duration when venous, traumatic, embolic, and nonatherosclerotic etiologies are excluded.

How Should I Diagnose PAD and CLTI?

PAD can be difficult to diagnose in the patient with neuropathy since the most recognized symptom of PAD, claudication, can be masked by the insensitivity. In fact, patients with PAD and neuropathy may present only with fatigue or weakness during ambulation and not typically claudicate. A history of cardiovascular risk factors, previous vascular interventions and smoking should be recorded. Patients with diabetes and chronic kidney diseases have a higher incidence of PAD.

CLTI is a more severe form of PAD and should be suspected in a patient with rest pain, gangrene, or tissue loss. Ischemic rest pain usually manifests in the forefoot and is worse at night. All patients with suspected CLTI should undergo a complete physical exam. The foot
should be inspected for tissue loss (ulceration) or gangrene, which are most commonly located on the toes or forefoot. Atrophic skin, lack of distal hair growth, and dystrophic toenails are all signs of PAD. With the patient lying supine, the foot and leg should be elevated at least 45 degrees from the hip for 60 seconds and any palorous color changes noted. Then the patient should be asked to sit with the foot in dependency and it should be examined for rubor.

Palpation of lower limb pulses should be performed but are not reliable in excluding PAD. This is a common misconception that the presence of pedal pulses indicates sufficient perfusion. In reality, the absence of a pedal pulse could be an indicator of PAD, but the presence of palpable pulses is not always a reliable indicator of adequate perfusion and a further noninvasive hemodynamic test should be performed.

“Pulse exam alone is insufficient to determine the presence of ischemia in the foot”

Ankle pressure and the ankle-brachial index (ABI) are recommended as the first-line noninvasive hemodynamic test in all patients with suspected CLTI despite the lack of reliability in those with diabetes and end stage renal disease due to calcified vessels leading to incompressible vessels (Grade 1/Strong, Level of Evidence B/Moderate). The correct method of calculating an ABI is to use a handheld Doppler and blood pressure cuff to measure the systolic
pressure of the brachial arteries in both arms and both the anterior and posterior tibial arteries in both ankles. The highest ankle pressure is divided by the highest brachial pressure.

Toe pressures and a toe-brachial index (TBI) may be more reliable in those with diabetes or incompressible vessels, but requires a minicuff and is usually performed on the hallux (Table 1).

There are other noninvasive methods of measuring perfusion or tissue oxygenation that are not as widely used, but may provide value (Grade 2/Weak, Level of Evidence C/Low). Skin perfusion pressure (SPP) was touted as a rapid and reliable method of determining wound healing potential and prediction of level of amputation healing; however, the device manufacturer ceased operations and the disposable components are unavailable. Transcutaneous oximetry measures the oxygen tension in the skin, but is time consuming and operator dependent. Promise exists with hyperspectral imaging, however the data is still lacking for widespread adoption.³

What Staging System is Recommended for CLTI Patients?

A limb-staging classification system should be used in all patients with suspected CLTI and be repeated after any foot or vascular surgery or when there is clinical deterioration (Grade 1/Strong, Level of Evidence C/Moderate). The Guidelines recommend using the WfI System to grade and stage CLTI patients.⁴ WfI is based on three essential elements in limb salvage; Wound, Ischemia, and foot Infection. The WfI System can help identify which patients would
benefit from revascularization\textsuperscript{5,6} and it also correlates with the outcome, particularly wound healing and amputation risk\textsuperscript{7,8}.

WIfI elements are graded 0,1,2,3 in increasing severity. The overall WIfI spectrum score would be reported as 3 numbers in the following format; W0-3 I0-3 fI0-3 (Table 2).

**Who Should Be Referred For Further Evaluation And Treatment Of CLTI?**

The Guidelines recommend all patients with suspected CLTI should be referred urgently to a vascular specialist. The adage “time is tissue” applies here. Delay is probably the largest contributing factor to limb loss. No where else in the body would ischemia be tolerated. Ischemic myocardium, ischemic bowel, and ischemic brain would be managed emergently. But ischemia in the lower limb is not usually treated with such urgency and the blame is multifactorial. Patients with diabetes often delay seeking medical attention because the ischemic changes, including frank gangrene, are typically painless. Medical providers may be apathetic to the ischemic lower extremity since patient’s are not complaining of pain and because they are under the misperception that an amputation will likely occur anyway, so there is no sense of urgency. Many hospitals or systems do not have a diabetic foot or limb team established with set referral patterns and treatment pathways.
Which Should Be Treated First, Infection or Ischemia?

Abscesses, wet gangrene, or gas gangrene are limb- and life-threatening and are surgical emergencies. If the foot or ankle are infected and ischemic, the infection should be managed emergently and revascularization considered once the infection is under control. We have seen podiatrists seeking “vascular clearance” to perform lower extremity surgeries; however, in the examples above, no vascular clearance is needed to treat a limb-threatening infection. Preferably, podiatrists and vascular specialists should work in close coordination to optimize care in these high risk settings, to avoid undue delays leading to further tissue loss. The goal is to remove all infected and necrotic tissue. Functionality is a secondary consideration when working to achieve source control for an advancing infection. Once the infection is managed and the limb perfusion optimized, it can be assessed for its functional status.\textsuperscript{9,10}

In most cases, osteomyelitis without abscess or superficial soft tissue infection (cellulitis) is not an emergency. The vascular specialist should be consulted to evaluate and optimize the perfusion when necessary before definitive surgery is performed to remove the osteomyelitis.

Who Needs to Be Revascularized?

Timely and effective revascularization plays a critical role in limb preservation. The WIfI scheme describes the full spectrum of CLTI, which includes ischemia-dominant, wound-dominant, infection-dominant and combination phenotypes. Thus the appropriateness of revascularization can be framed in this context. Within each WIfI stage, the severity of ischemia
is the critical determinant of the expected benefit of revascularization (Table 3). All CLTI patients who have severe ischemia and are appropriate candidates for limb salvage should be considered for revascularization up front (Grade 1/Strong, Level of Evidence C/Low). In settings of moderate ischemia, revascularization may be of benefit when there is advanced tissue loss, infection, or both. In other scenarios of minor tissue loss/infection and mild to moderate ischemia, wound care and infection control may be adequate to achieve resolution. In these cases revascularization may be appropriate selectively if there is worsening of Wifl stage or failure to improve over 4-6 weeks of monitoring. A point worth emphasizing is the importance of re-staging patients over time, after surgical control of infection/debridement, and following revascularization, to assess progress. Deterioration or failure to improve in Wifl stage is an indicator to re-evaluate all aspects of the treatment plan.

“Even if a prior revascularization procedure was successful, given the risk of restenosis or bypass compromise, the perfusion should be reassessed prior to performing subsequent foot surgery.”

How Should CLTI Patients Be Followed?

Effective revascularization needs to provide adequate increases in foot perfusion, for sufficient durability, to resolve CLTI. Despite high technical success rates of endovascular interventions in improving perfusion to the lower extremity, restenosis is common. Open bypass using vein or prosthetic grafts may also fail by stenosis in the graft or narrowing at the anastomosis sites. The
Guidelines recommend periodic surveillance by duplex ultrasound and ABI/TBI at 3-6 month intervals and whenever there is clinical suggestion of worsening perfusion or overall limb status. It is of utmost importance for the podiatrist to realize that just because a technically successful revascularization procedure was performed, distal flow to the foot may still be compromised and the effectiveness (i.e. patency, perfusion pressures) of the vascular intervention should be reassessed before foot surgery can safely be performed.

What is the Role of the Podiatrist on the CLTI Team?

There is robust evidence that multidisciplinary, team-based care results in better outcomes and reduced health expenditures for those with diabetic foot problems and CLTI.11,12,13 Podiatry’s role on that team cannot be overstated. A surgical podiatrist can perform many of the essential skills needed on a limb salvage team.14,15

Specifically, a podiatry-led team model resulted in 72% fewer amputations in a county hospital in the US.16 The addition of podiatry to an academic medical institution resulted in an average of 40 fewer major amputations annually over 16 years.17 The Department of Veterans Affairs relies heavily on podiatry in their high-risk foot clinics which has had a positive impact on reducing amputations.18,19 In a study of approximately 48,000 Medicare- and commercially-insured patients who received care by a podiatrist were statistically less likely to be hospitalized or undergo a major amputation.20 In a 5% sample of Medicare patients from 1991-2007, patients were 31% less likely to undergo amputation if they had a foot ulcer or 77% less likely if
they had cellulitis and were treated by a podiatrist. In an analysis of 100 million patient encounters, integration of specialized podiatric services cut the number of major amputations in half. Podiatry’s involvement also significantly reduced the cost of care to patients with diabetic foot ulcers.

In 2010, as part of the APMA-SVS Alliance, we described the “Toe and Flow” model of care to prevent amputations which consists of a podiatrist and a vascular specialist at the core. Since then, the model has been shown to be successful in numerous settings and has been implemented more and more widely. More recently, in Canada, the multidisciplinary team (“toe and flow”) model was implemented in Calgary and compared with Edmonton, where the provincial standard of care lacks this team-based coordination for the diabetic foot. The Calgary zone had a 45% lower rate of major amputation providing strong evidence for the podiatry-vascular model.

When Should an Amputation Be Considered?

Amputation, while avoidable in most cases, is sometimes a necessary procedure for patients with CLTI. In the face of overwhelming soft tissue infection, a minor or major amputation may be needed to preserve limb and/or life. Usually, these urgent amputations are staged to control the infection first, then perfusion and function will dictate the definitive secondary procedure or reconstruction of the limb.
Major amputations are not without risks. The 30-day postoperative mortality rate is as high as 22\%\textsuperscript{31} and the 5-year relative mortality rate in diabetes-related major amputation is 70\%\textsuperscript{32,33} a worse prognosis than many cancers. Mortality isn’t the only risk. After amputation, a contralateral amputation is performed in up to 44\% of patients.\textsuperscript{34}

The main goals of limb salvage are to preserve or restore independent ambulation and improve quality of life for the patient. Minor amputations (foot sparing) are sometimes staged to control infection or remove gangrene after perfusion is optimized. Foot function should be considered for definitive amputation planning. Removal of a single digit or ray can leave a foot with sufficient function.\textsuperscript{35,36} In some cases, TMA may be the better first procedure and it should be considered in CLTI patients who require more than 2 digital amputations, especially if the hallux is involved.\textsuperscript{37}

But in cases when an aggressive attempt at limb salvage would be unlikely to succeed or pose too great of a physiologic stress on a patient, or result in a nonfunctional foot, a well-planned primary amputation should be considered (Grade 1/Strong, Level of Evidence C/Low). Primary amputation is defined as a lower extremity amputation without an attempt at open or endovascular revascularization.

The major indications for primary amputation are:

1. Non-reconstructable arterial disease
2. Destruction of the major weight-bearing surface of the foot rendering it incompatible with ambulation
3. Non-functional lower extremity due to paralysis or unremediable flexion contractions

4. Severe comorbid conditions that limit life expectancy

5. Multiple surgical procedures need to restore a viable lower extremity

For patients who are undergoing primary amputation, revascularization should be considered to improve the inflow to keep the level of the amputation as distal as possible and improve the primary healing potential (Grade 2/Weak, Level of Evidence C/Low).

Secondary amputation is performed after one or more attempts at revascularization have failed and the likelihood of further procedures have limited chance of success (Grade 2/Weak, Level of Evidence C/Low).

The Guidelines recommend best practices for the delivery of amputation service as:

1. The indication for any amputation should be discussed at a multidisciplinary team meeting after a full functional and vascular assessment

2. Patients should be informed as to the rationale of any amputation as well as the post-amputation care pathway

3. Patients should have access to a second opinion (by a vascular specialist from another institution)

4. A preoperative assessment by a rehabilitation and occupational physical therapist as well as by a prosthetic specialist should be organized

5. Procedures should be performed on an elective list within 48 hours of the decision
6. Amputations should be performed by (or in the presence of) a board-certified consultant surgeon

7. A named discharge coordinator should ensure that there is a defined post-amputation care pathway

CONCLUSIONS

The Global Vascular Guidelines provide a comprehensive review of the evidence and best practice recommendations for the care of the patient with chronic limb-threatening ischemia. In this case, no man, woman, or clinician, is an island. To truly care for the threatened limb, one must create a team of those with the passion and necessary skills. The role of the podiatrist on this team is paramount to the success of the mission.

Financial Disclosure: This study is partially supported by National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases Award Number 1R01124789-01A1

Conflict of Interest: None reported.

REFERENCES


This Special Communication has been reviewed, accepted for publication, and approved by the author. It has not been copyedited, proofread, or typeset and is not a final version.

2014;60(6):1535-1542. doi:10.1016/j.jvs.2014.08.107


22. Schmidt BM, Holmes CM, Ye W, Pop-Busui R. A Tale of Two Eras: Mining Big Data from


29. Basiri R, Haverstock BD, Petrasek PF, Manji K. Reduction in Diabetes-Related Major

doi:10.7547/19-137


doi:10.3402/dfa.v3i0.18633


doi:10.1016/j.jvs.2013.06.055


TABLE 1. Reference values for recommended noninvasive hemodynamic tests.

<table>
<thead>
<tr>
<th>Grade</th>
<th>WOUND (W)</th>
<th>Gangrene</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No ulcer</td>
<td>No gangrene</td>
</tr>
<tr>
<td>1</td>
<td>Small shallow ulcer, no exposed bone</td>
<td>No gangrene</td>
</tr>
<tr>
<td>2</td>
<td>Deeper ulcer with exposed bone, joint, or tendon; or shallow heel ulcer without calcaneal involvement</td>
<td>Gangrenous changes limited to digits</td>
</tr>
<tr>
<td>3</td>
<td>Extensive deep ulcer involving forefoot and/or midfoot, deep full-thickness heel ulcer +/- calcaneus exposure</td>
<td>Extensive gangrene involving forefoot and/or midfoot, or full-thickness heel necrosis</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade</th>
<th>ABI</th>
<th>Ankle Systolic Pressure</th>
<th>TP, TcPO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>≥0.80</td>
<td>&gt;100 mmHg</td>
<td>≥60 mmHg</td>
</tr>
<tr>
<td>1</td>
<td>0.6-0.79</td>
<td>70-100 mmHg</td>
<td>40-59 mmHg</td>
</tr>
<tr>
<td>2</td>
<td>0.4-0.59</td>
<td>50-70 mmHg</td>
<td>30-39 mmHg</td>
</tr>
<tr>
<td>3</td>
<td>&lt;0.39</td>
<td>&lt;50 mmHg</td>
<td>&lt;30 mmHg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade</th>
<th>Clinical Description</th>
<th>IDSA Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No symptoms or signs of infection</td>
<td>Uninfected</td>
</tr>
<tr>
<td>1</td>
<td>Local infection with &lt;2 cm surrounding erythema, no deep spread. no osteomyelitis</td>
<td>Mild</td>
</tr>
<tr>
<td>2</td>
<td>Local infection with &gt; 2 cm surrounding erythema or involving deeper structures (abscess, osteomyelitis, septic arthritis, tracking along a tendon, fasciitis), no systemic signs</td>
<td>Moderate</td>
</tr>
<tr>
<td>3</td>
<td>Local infection with signs of SIRS as manifested by two or more of the following; temperature &gt;38 or &lt;36 degrees C, HR &gt;90 BPM, respiratory rate &gt;20/min, WBC &gt;12,000 or &lt;4,000 or &gt;10% bands</td>
<td>Severe</td>
</tr>
</tbody>
</table>
TABLE 2. The Wfij Threatened Limb Classification System adapted from Mills et al.⁴

<table>
<thead>
<tr>
<th>Noninvasive Hemodynamic Arterial Tests</th>
<th>ABI</th>
<th>Toe Pressure</th>
<th>TBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noncompressible/Calcified</td>
<td>&gt;1.4</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Normal</td>
<td>0.9-1.39</td>
<td>≥60 mmHg</td>
<td>&gt;0.7</td>
</tr>
<tr>
<td>Mild PAD</td>
<td>0.7-0.89</td>
<td>40-59 mmHg</td>
<td>0.5-0.69</td>
</tr>
<tr>
<td>Moderate PAD</td>
<td>0.5-0.69</td>
<td>30-39 mmHg</td>
<td>0.35-0.49</td>
</tr>
<tr>
<td>Severe PAD</td>
<td>&lt;0.5</td>
<td>&lt;30 mmHg</td>
<td>&lt;0.35</td>
</tr>
</tbody>
</table>

TABLE 3. Benefit of revascularization is related to severity of ischemia and overall Wfij stage.

<table>
<thead>
<tr>
<th>Severity of Ischemia (Wfij Grade)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>N/A</td>
<td>HIGHLY LIKELY</td>
<td>HIGHLY LIKELY</td>
<td>HIGHLY LIKELY</td>
</tr>
<tr>
<td>2</td>
<td>N/A</td>
<td>POSSIBLE</td>
<td>POSSIBLE</td>
<td>HIGHLY LIKELY</td>
</tr>
<tr>
<td>1</td>
<td>LOW/NIL</td>
<td>POSSIBLE</td>
<td>POSSIBLE</td>
<td>POSSIBLE</td>
</tr>
<tr>
<td>0</td>
<td>LOW/NIL</td>
<td>LOW/NIL</td>
<td>LOW/NIL</td>
<td>LOW/NIL</td>
</tr>
</tbody>
</table>

Limb Severity (Wfij Stage)