Chronic Wound Care of the Lower Extremities: What Every Vascular Specialist Needs to Know

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Abstract

Wound care is a complex but essential skill for any vascular specialist. This review discusses how to evaluate the underlying causes of chronic wounds and how to characterize a wound during initial workup, and provides an overview of holistic wound care treatment including the use of dressings, skin substitutes, and risk factor optimization. Caring for arterial, venous, and diabetic wounds is specifically reviewed in further detail.

J CRIT LIMB ISCHEM 2025:5(2):E20-E28. doi: 10.25270/jcli/CLIG24-00007

Key words: wound care, chronic wounds, diabetic foot ulcers, arterial insufficiency, venous insufficiency

Chronic wounds affect an estimated 2% of the US population[1] and, on an individual level, are a constant visual reminder of suboptimal health and potentially significant morbidity and mortality. Common underlying vascular factors related to nonhealing and chronic wounds of the lower extremities include venous and arterial insufficiency, which are often addressed by a variety of vascular specialists. Early optimization of the underlying factors related to these wounds may prevent a prolonged course of wound care (sometimes years, in the case of venous ulcers). In some cases, timely intervention can reduce preventable amputations. Therefore, knowledge of basic wound evaluation, treatment strategies, and troubleshooting are valuable skills required to treat this debilitating condition. Vascular specialists should develop a level of understanding in the elements of wound care to improve outcomes for their patients.

Basics of Wound Evaluation and Workup

Since its introduction by an expert panel in 2003, the Tissue, Infection/Inflammation, Moisture, and Edge (TIME) paradigm has been a widely accepted method of evaluating a wound. However, advances in our understanding of the underlying biochemistry of wound healing have led to inevitable criticisms about TIME's simplicity. More nuanced evaluation criteria now consider wound bed preparation, medical comorbidities, and nutritional status, and have led to more holistic wound care models.[2] While an in-depth discussion of all possible factors that contribute to wound healing is beyond the scope of this paper, we highlight key wound characteristics and social determinants of health that impact wound care.

Initial evaluation starts with the wound itself (**Figure 1**). Wound location and dimensions including length, width, and depth should be noted, in addition to the presence of undermining and tunneling. Look for wound bed granulation tissue, which indicates good healing potential, or its absence or replacement with fibrinous tissue, which indicates the need for further wound bed optimization. The presence and amount of wound drainage may provide insight into the underlying etiology and determine which wound dressings are most appropriate. Pay careful attention to any signs of infection such as malodor, purulence, or disproportionate pain. If localized infection is present, cleansing the wound, obtaining cultures using the Levine technique, and potential antibiotic administration should be considered. If even subtle signs of systemic infection are noted, send the patient to the emergency department or directly admit the patient for potential intravenous antibiotic treatment. If there is even a remote concern for difficult, indolent, or recalcitrant infections early on, guidance from infectious disease colleagues can prove invaluable. See **Table 1** for further details regarding initial wound parameters and their importance.

After thoroughly evaluating the wound, do the same for the patient. Underlying medical conditions such as diabetes,

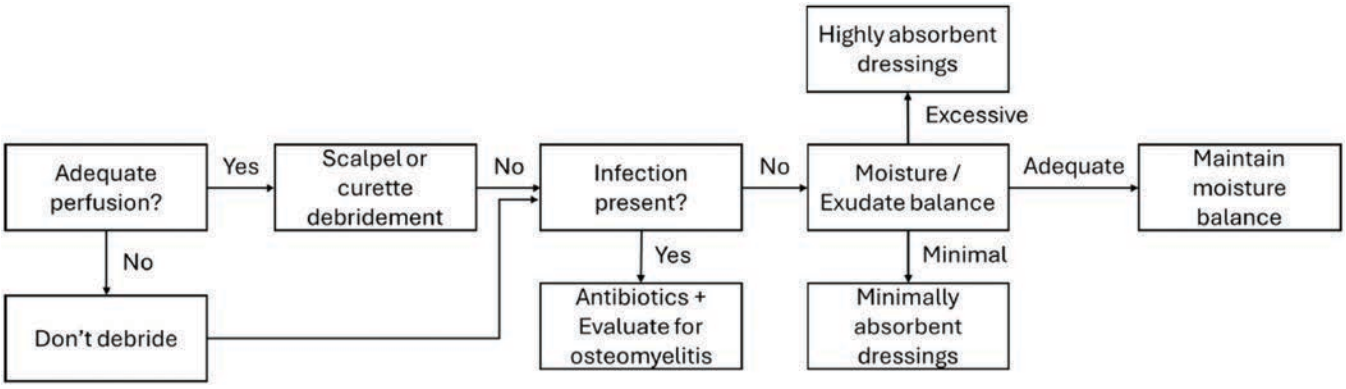

FIGURE 1. This flowchart demonstrates our clinic's basic workflow for new wound evaluations. Always evaluate for the underlying etiology of the wound and any medicosocial factors that may limit wound healing. Refer to Table 2 for products that could be used to maintain moisture balance.

collagen vascular disorders, and autoimmune conditions may contribute to poor wound healing, as will certain prescriptions such as nonsteroidal anti-inflammatory drugs (NSAIDs), steroids, chemotherapeutics, and other immunosuppressants. Always ask about smoking history, as active smoking will directly restrict wound healing.[3] Insights into the patient's support system will also be helpful because chronic wound care requires, at a minimum, weekly/bimonthly clinic visits, sometimes for months on end. Reliable transportation, access to assistance with dressing changes, the need for nursing home health visits, and continuous health insurance should be considered during the initial (and subsequent) visits. While addressing and optimizing these factors are not always possible, attempts to improve them can have significant impact on wound outcomes.

While often overlooked, pay close attention to nutritional status. Inquire about eating habits, protein intake, vitamins, and weight changes. A number of well-validated tools are available to screen for malnutrition, such as the Malnutrition Universal Screening Tool,[4] Mini Nutritional Assessment,[5] and Nutritional Risk Index.[6] Micronutrient deficiencies such as vitamin C and zinc may also impair healing[7] and can be measured by routine lab testing if indicated. Liquid nutritional supplements can also be of considerable benefit to patients who have poor nutrition, and some have anecdotally reported wound healing using nutrients such as Juven (Abbott). Consider a dietary consult if you believe undernutrition may be contributing to a lack of wound healing.

After an initial evaluation, a provider can often predict the underlying etiology for the wound. For instance, a chronic wound in the gaiter region with significant drainage in a patient who stands for most of their workday likely stems from venous insufficiency. However, a newly developed toe pad wound in a smoker with claudication or diminished lower extremity pulses is likely secondary to arterial insufficiency. Diabetic foot ulcers (DFUs) may be the sequelae of years of neuropathy, abnormal biomechanics, poorly controlled diabetes, and inadequate attention to foot care. Regardless of the underlying etiology, the initial treatment considerations for wounds have significant overlap.

Initial Treatment Considerations

For the body to heal a wound, it must establish hemostasis, eliminate infection, and create granulation tissue.[8] Only then can the skin's basal cells multiply, differentiate into keratinocytes, and go on to create an intact barrier that will eventually remodel and become more durable skin. Patients may arrive at a wound care clinic at any step along this sequence. Therefore, several key clinical questions arise: 1) How can a wound infection be treated (or prevented)? 2) How can a wound bed be optimized for granulation tissue? and 3) How can the underlying cause of the wound be treated to prevent delayed healing?

Initial evaluation in our wound care center begins with removal of any dressings and saline-based cleansing of the skin, followed by application of topical lidocaine or other topical anesthetic to the wound. The wound is then evaluated in detail using the parameters in **Table 1** and gently debrided with a curette or scalpel if indicated. Sharp debridement is the gold standard for removing any overlying slough/biofilm; it promotes wound healing[9] and provides an adequate view of the wound bed, and should be performed whenever appropriate. Other methods of debridement that have shown promise (although not widely adopted) include ultrasound wound cleansing[10] and hydrosurgery.[11] One note of caution: If the wound is thought to be secondary to arterial insufficiency, debridement should be deferred until the patient has been revascularized or confirmed to have adequate perfusion by a vascular specialist. Arterial perfusion can be initially assessed with a pulse examination (either with manual palpation or use of a portable Doppler). Noninvasive near-infrared spectroscopy has also shown promise in assessing tissue oxygenation[12] and may be another useful tool to assess for wound perfusion and wound healing potential if available.[13]

Once the wound bed has been adequately prepared, a key question arises: Is this wound infected, and if so, how extensive is the infection? If the wound is infected, cultures should be obtained using the Levine technique,[14] in which a swab is rolled over a 1-cm^2 area within the wound with enough downward pressure

Table 1. Key wound and social evaluation parameters

Parameter	How to evaluate	Why is it important?
Size	Measure length and width.	Trends in size may indicate treatment success or failure.
Depth	Measure from skin surface to deepest portion of wound.	Trends may indicate treatment success or failure.
Undermining	Use a moist swab to measure how deep the wound is laterally, beneath any overlying skin edge.	Undermining can harbor infection.
Tunneling	Use a moist swab to see if the wound tunnels to under areas.	Tunneling can harbor infection.
Infection	Indicated by purulent discharge, odor, and wound color.	Infection impedes healing.
Wound base	Is there granulation tissue, fibrinous tissue, or a significant amount of exudate visible?	Wound base characteristics guide treatment options.
Drainage	How many gauze pads does the wound soak while waiting for the provider to see the patient?	Excess drainage can macerate wound edges and prohibit the use of skin substitutes.
Moisture content	Is the wound dry, or is there excessive drainage?	Some moisture is needed for wound healing.
Wound location	Where exactly on the body is the wound?	Location may indicate pathology.
Smoking status	Is the patient actively smoking?	Smoking directly inhibits wound healing.
Nutritional status	Does the patient consume an adequate amount of calories and protein?	Nutritional deficiencies can impair wound healing.
Transportation access	Can the patient keep scheduled appointments?	Chronic wound care requires weekly in-clinic evaluation and frequent dressing changes.
Mobility status	Can the patient perform activities of daily living and dressing changes?	If daily dressing changes are needed, help from a home nurse or family member may be necessary.
Lower extremity biomechanics	Measure range of motion at the ankle and foot joints; evaluate for soft tissue contractures.	Altered biomechanics and lack of normal range of motion may lead to repetitive focal stress and wound formation.
Foot deformity	Evaluate foot anatomy for altered structural changes.	Abnormal foot anatomy may contribute to altered biomechanics and foot deformity, leading to pressure-induced wounds.

to express fluid from the wound. If the wound does not appear grossly infected, careful consideration must be given to the presence of biofilm, which can also delay wound healing. If present in sufficient quantity, biofilm-containing slough can appear as a thin, shiny, viscous layer overlying a wound bed. However, biofilm (if present) is usually invisible and is best dealt with sharp (curette or scalpel) debridement. Fluorescence-based methods of detecting porphyrin-producing bacteria[15,16] and biofilm[17] have shown promise in early clinical testing at wound care centers and may be another useful diagnostic tool if available. In cases where the wound has been refractory to targeted antimicrobial therapy, excisional, incisional, or punch biopsies should be used for further evaluation. Once cultures are obtained, initiate topical or oral antibiotics with polymicrobial coverage (clindamycin, ampicillin-sulbactam, or cephalexin are recommended by the Centers for Disease Control and Prevention) until confirmatory results are back. If there is concern for methicillin-resistant *Staphylococcus aureus* infection, consider prescribing antibiotics with appropriate coverage.

The use of wet-to-dry gauze dressings with twice- or thrice-daily changes may help with short-term mechanical debridement. The use of alginate or absorbent foam with daily dressing changes is also sufficient to remove any significant amount of exudate and help establish control of an infection in the interim. However, if bone is exposed during curette or excisional debridement, or probing of the wound reveals tunneling toward bone, order plain film radiographs or magnetic resonance imaging (MRI) to evaluate for underlying osteomyelitis.[18] If the patient is septic, hospital admission for further workup and more aggressive antimicrobial therapy may be warranted. Consider an infectious disease consultation, especially if the infection is refractory to initial therapy.

Next, consider the moisture content and drainage of the wound. While somewhat subjective, wounds should be moist enough to promote wound healing but not so moist that the wound edge becomes macerated or that the wound bed is likely to become infected. If the wound has a large amount of drainage, absorbent dressings such as alginates or gelling fibers may be helpful.[19] Application of multilayer compression dressings may be appropriate in patients with venous insufficiency wounds who have an ankle-brachial index (ABI) greater than 0.70 (from our experience). If the wound has little or no moisture, hydrogel or medical-grade honey coupled with a nonabsorbent foam may

be suitable to maintain appropriate hydration. See **Table 2** for a more extensive list of dressing types and when to use them.

Chronic wounds can also be physically painful for patients. Ensuring that pain has improved between visits is an important consideration, and use of acetaminophen or topical lidocaine may be beneficial. Avoid using NSAIDs as they can impair wound healing.[20]

Finally, it is critical to initiate a workup for the underlying etiology during the initial visit. For arterial insufficiency wounds, this entails a thorough vascular physical exam, obtaining ABIs, toe-brachial indices (TBIs), and possible arterial duplex studies, as well as smoking cessation and glycemic control if appropriate. Of note, an ABI may not adequately detect inflow disease in patients with diabetes due to noncompressible medial calcific stenosis in infrapopliteal arteries, and as such, arterial duplex studies or computed tomography angiography may be needed for further evaluation.

For chronic venous insufficiency, order venous reflux ultrasound studies and multilayer compression garments, and ensure appropriate management of any underlying medical disorders that result in volume overload. Some patients are unaware of prior deep vein thrombosis events, inferior vena cava filter placement, and other venous issues related to venous thromboembolism that may be contributing to their chronic lack of healing. A thorough history and exam may lead the specialist to obtain cross-sectional imaging to find central venous occlusions and other relative causes of insufficiency.

For DFUs, obtain a hemoglobin A1c, ensure compliance with hyperglycemic medications, and screen for arterial disease and osteomyelitis. It cannot be overemphasized how critical management of underlying disease and smoking/nutrition status are for wound healing. Offloading is a particularly important consideration. Total contact or removable casts are considered the gold standard for initial treatment, while orthotics are used to maintain healing. Once treatment is initiated and dressings and ointments are provided, make sure the patient is scheduled for weekly return visits for dressing changes and continued wound evaluation.

Table 2: Dressing, Ointments, Solutions, and Their Indications

Dressing	Level of drainage tolerated	Can it be used with infection?
Alginate	High	Yes
Gelling fibers	Moderate-high	Yes
Absorbent foam	High	Yes
Hydrocolloids	Minimal	Yes
Hydrogels	Minimal/none	No
Ointments/gels	**Okay to use if there is exudate or drainage?**	**Can it be used with infection?**
Medical-grade honey	No	Yes
Collagenase Santyl	Yes	No
Silver hydrogel	Low drainage	Yes
Solutions		
Iodine	No	Yes; arterial insufficiency
Hypochlorous acid	Purulence, low drainage	Yes
Sodium hypochlorite	Purulence, low drainage	Yes
Hydrogels	No	No

Table 3: Biologic Products Used for Wound Cares

Product	Best for	Contraindication
Living skin substitute	Venous leg ulcers, diabetic foot ulcers	None
Synthetic extracellular matrix	Diabetic ulcers, large wounds	None
Human placental tissue	Any wound	None
Fish skin	Chronic vascular ulcer, diabetic ulcers, some draining wounds	Fish allergy/ sensitivity
Porcine extracellular matrix	Tunneling/ undermining	Pig allergy

Maintenance and Troubleshooting

Wound evaluation during follow-up visits is not substantially different from the initial visit. Wound size, depth, base characteristics, infection, and drainage should all be noted. Several more nuanced tools such as the Bates-Jensen Wound Assessment Tool[21] and Pressure Ulcer Scale for Healing[22] have been developed to objectively determine if wound healing is progressing or regressing and are vital for monitoring wound progress. If the wound size is progressively decreasing with each weekly clinic visit, the current treatment regimen is likely enough.

If wound healing has not improved by 50% within 4 weeks, it is unlikely to change significantly in size as demonstrated by Sheehan et al,[23] and a change in wound care strategy may be needed to resume healing. Reassess the wound for signs of infection, particularly if there is undermining. In some cases of wound infection, topical antimicrobial dressings impregnated with polyhexamethylene biguanide (PHMB),[24] silver,[25] and honey[26] have also been shown to reduce wound size, pain, and bacterial burden. While there is no clear consensus on which product should be used for which particular type of wound, each product has its own benefits and risks. PHMB, for instance, does

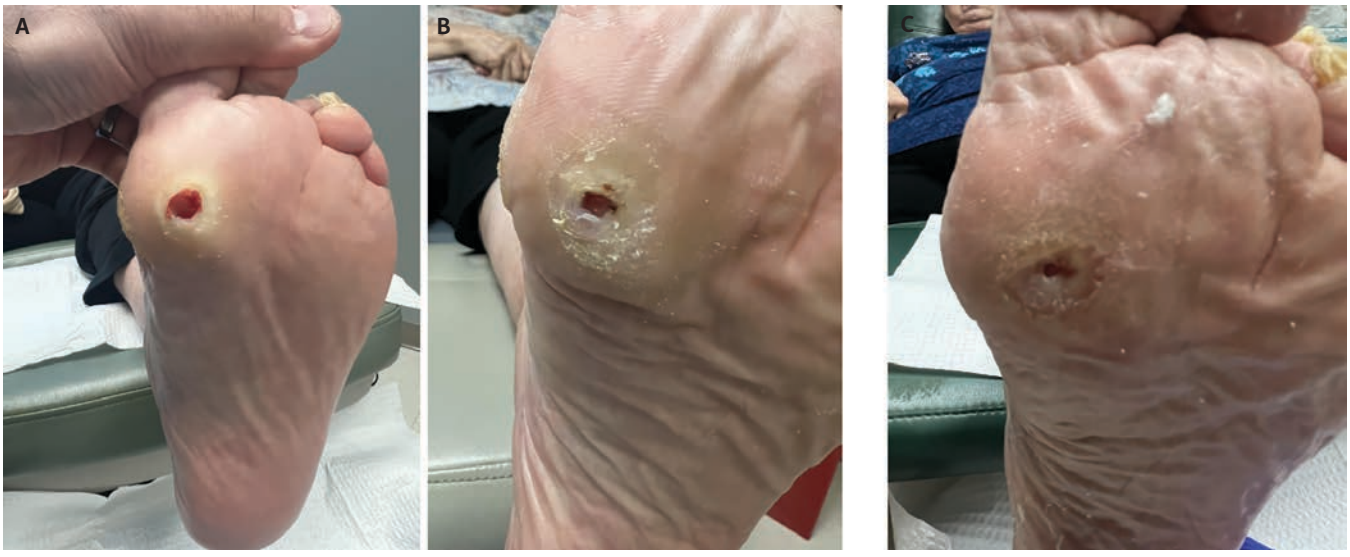

FIGURE 2. Typical diabetic foot ulcer progress in 4 weeks with debridement, offloading, and moisture balance.

not appear to develop antibacterial resistance with long-term use, although patients may become sensitized to the product over time. Silver dressings have known bactericidal properties but may be cytotoxic and eventually impair wound healing. Antimicrobial dressings should be trialed for a short period of time (for instance, a "2-week trial" approach has been adopted in the UK for silver dressings) and, based on wound response, changed or maintained on a case-by-case basis. Of note, prophylactic antibiotics have not been shown to prevent infections in chronic wounds and should not be routinely prescribed,[27] given the risks of antibiotic resistance and unintended adverse effects of chronic antibiotic therapy.

Ensure granulation tissue is still present or prescribe chemical or enzymatic debridement if excessive fibrinous tissue has formed. Verify that the moisture content of the wound is adequate by checking for macerated or desiccated edges. Often, drainage from the wound will change as treatment progresses, and a dressing that adequately removes moisture at one point in time may become too aggressive at a later point.

Targeted questioning may be needed to ensure compliance with treatments, whether it be diuretics for underlying medical conditions, smoking cessation, or adequate nutrition intake. For venous wounds in particular, ensure patients are compliant with dressing changes, which can be messy and distressing, and multilayer compression wraps, which can be difficult to apply and uncomfortable to wear. If patients need more frequent help at home with dressing changes, home health nursing or more frequent clinic appointments for dressing changes may be appropriate. If changing the treatment strategy does not work, reassessing the underlying vascular abnormality may be warranted and more aggressive treatment may be required. If there is no improvement after 4 weeks, consideration of artificial, human-derived, or animal-derived products may be indicated. Many products, from living skin substitutes to fish skin, synthetic extracellular matrix, and human placental tissue, have been used with varying degrees of success (**Table 3**). However, these products need to be in contact with clean, viable tissue to be effective and are contraindicated in wounds with inadequately prepared wound beds, excessive drainage, or infection. In addition, not all insurance policies cover these treatments, which can be quite costly and require weekly reapplication.

Hyperbaric oxygen therapy (HBOT) can also be considered in nonhealing wounds of appropriate etiology and may have particular benefit for diabetic ulcers.[28] Patients undergoing HBOT are placed into a small chamber with elevated oxygen levels (near 100%) and increased atmospheric pressure for a predetermined amount of time. The resulting increased blood oxygen levels lead to increased reactive oxygen species, which help reduce infection and may stimulate angiogenesis, which further promotes wound healing.[29] Historically, HBOT has had varying levels of success and requires multiple visits; further large-scale randomized controlled trials are needed to gauge its effectiveness. HBOT is contraindicated in patients with claustrophobia, heart failure, and obstructive lung disease, among other conditions.

Negative pressure wound therapy[30] (NPWT) has also been shown to be effective for various wounds.[31] It works by mechanically deforming the wound on a macro- and microscopic level to promote cellular proliferation, angiogenesis, and removal of inflammatory exudate and has proven effective for DFUs, surgical wounds, and other nonhealing wounds. Patients will have their wound debrided, a sponge or other compatible dressing placed over the wound, and an impermeable barrier placed on top of the sponge/dressings extending beyond the wound edge to create a durable seal. This setup is then connected to a portable vacuum, which creates a negative-pressure environment. Certain devices also provide options to instill antibiotic solutions in the wound

FIGURE 3. A) Male patient in his 70s with a history of diabetes, hypertension, and coronary artery disease who presented with a lateral forefoot wound that was not healing. He also had rest pain recalcitrant to oral medications. B) After debridement by outside podiatry, he was noted to have a worsening wound. Noninvasive studies demonstrated significant peripheral arterial disease with an ankle-brachial index of 0.5 and toe pressure of 20 mm Hg. The decision was made to perform an angiogram. C) Angiogram digital subtraction image shows perfusion consistent with a "desert foot" with a small vessel disease pattern. This patient was not a candidate for endovascular or surgical arterial-based revascularization. Typically, these patients undergo a major amputation (above or below the knee), which carries a very high 5-year mortality rate. D) The patient underwent a successful deep venous arterialization (DVA) procedure. E) The patient's wound was closely monitored and subsequently required first-ray amputation 8 weeks after DVA creation. F, G) With subsequent debridement, dressings, and wound vacuum utilization (negative pressure wound therapy), the amputation site gradually healed and the patient reported improved pain and ambulation. H) An angiogram performed at 3 months showed an occluded DVA but with clear evidence of increased arterialization, a well-known phenomenon of DVA.

bed, while others have antimicrobial sponges that can be placed to help with infection. General contraindications to NPWT include untreated osteomyelitis, poor vascular supply, and wounds with exposed neurovasculature.

Common Scenarios

Below are several common clinical scenarios with their initial workup, treatment, and troubleshooting.

Diabetic Foot Ulcers

Patients will typically present with DFUs at bony prominences of the foot, typically at pressure-bearing areas of the plantar foot (metatarsal head, hallux interphalangeal joint, plantar heel, and distal tuft of toes). Dorsal foot ulcers also occur but are less common compared with the typical plantar DFU, especially given the altered biomechanics associated with peripheral neuropathy in these patients. Initial evaluation includes a thorough wound exam as previously described, simple neurological evaluation by a monofilament examination to document the level of peripheral neuropathy, a vascular exam (ABI/TBI), and infectious workup if appropriate. Of note, most patients with DFUs have concomitant peripheral arterial disease, which needs to be addressed immediately to ensure adequate wound healing. An x-ray of the foot is usually taken upon initial evaluation to rule out underlying bone infection. If osteomyelitis is suspected, further workup with MRI or a nuclear-tagged white blood cell bone scan is appropriate. Adequate perfusion and absence of infection are paramount to initiation of the wound-healing process.

The initial treatment plan for DFUs consists of 3 principles: 1) Debridement, 2) Offloading, 3) Infection management (if applicable), and 4) Moisture balance (**Figure 2**). Debridement is typically performed with a 15-blade or 10-blade and a curette, taking care to remove the hyperkeratotic border and devitalized slough to facilitate a healthy, bleeding, granular base. Offloading options are then discussed with the patient. Custom diabetic inserts, offloading pads, a Charcot restraint orthotic walker, a total contact cast, and a knee scooter are all viable options. Patient compliance with offloading is often the most troubling and needs to be addressed at each visit. The wound dressing is applied post-debridement, taking care to regulate moisture balance. Prescription wound dressings are ordered

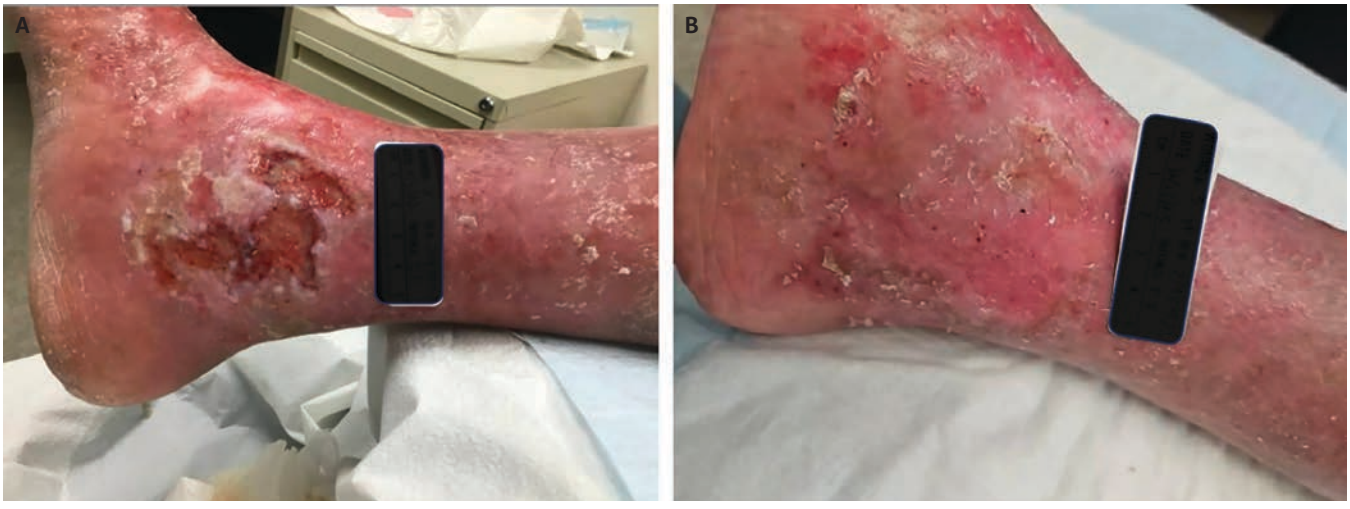

FIGURE 4. A patient with venous lymphedema and a persistent medial malleolar wound for 3.5 years. The wound was treated with weekly multilayer compressive dressings, various wound care agents, and lymphedema pumps. The patient also underwent superficial great saphenous vein ablation and periwound variceal sclerosis. The wound healed 9 months later. By controlling fluid balance, encouraging ambulation and weight loss, and continued use of compressive stockings and lymphedema pumps, his lifelong risk of recurring ulcers should be reduced.

based on moisture control, and a home health nurse can be prescribed to ensure regular dressing changes.

Patients are typically seen weekly for routine evaluation and, if indicated, debridement. Wounds are measured at each visit with the goal being 50% reduction of size in 4 weeks. Failure to obtain wound closure by 50% in 4 weeks may qualify patients for advanced skin substitute use (cellular, acellular, and matrix-like products; see **Table 3**). If approved by insurance, skin substitutes are applied directly after wound debridement on a weekly basis to supplement healing. If infection workup determines osteomyelitis is present, further surgical and nonsurgical treatment should be decided on a case-by-case basis. Surgical treatment is typically indicated in patients with sepsis, bony destruction, infected joint spaces, or necrotizing soft tissue infection,[32] aiming to remove infected bone, preserve both foot function and pressure distribution, and prevent ulcer recurrence or transfer ulcer creation. Medical therapy, on the other hand, may be preferred in non-septic patients, patients with high-risk comorbidities precluding surgery, and cases with forefoot osteomyelitis in which the patient's normal underlying biomechanics are preserved. Of note, medical therapy does not always involve intravenous antibiotics, as certain oral antibiotic regimens have been shown to be as effective as intravenous therapy in the appropriate patient population.[33]

Arterial Insufficiency

Patients typically present with toe/foot ulcers with varying severity of tissue damage, which can be characterized by the Rutherford and Wound, Ischemia, and foot Infection[34] classification systems. Secondary signs of arterial insufficiency include shiny ruborous skin, lack of hair, toenail abnormalities, and claudication. The presence or absence of palpable/Dopplerable pulses should be noted on initial examination and every follow-up visit. Do not debride the wound with a curette or scalpel on the initial visit, as the lack of perfusion will limit healing and debridement may lead to excessive soft tissue loss. In our clinic, we treat these wounds initially by wrapping the wound in iodine-soaked gauze and gently applying wet-to-dry dressings. Do not use compression stockings in patients with suspected arterial insufficiency, as this will further limit arterial supply and hinder wound healing. Once adequate perfusion is confirmed, compression stockings may be used if needed.

Begin a diagnostic workup if arterial issues are suspected, including ABI/TBI, arterial duplex, and if appropriate, angiogram with possible interventions and/or consideration of arterial bypass. Once perfusion has been restored, the wound may be sharply debrided. If wound healing has stalled, reassess ABI/TBI or arterial duplex, compliance with smoking cessation, and management of other underlying comorbidities. If the underlying vascular disease appears to worsen, the wound will not heal and may require referral to an experienced center for more aggressive treatments, such as tibiopedal access revascularization and deep venous arterialization (DVA) (**Figure 3**).

Venous Insufficiency

Patients typically present with ulcers along the medial malleolus, gaiter region, and dorsal feet, and can be categorized according to the CEAP[35] Classification and the Revised Venous Clinical Severity Score.[36] Many also present with chronic skin pigmentation, lower extremity edema, and varicose veins. Take note of the amount of wound drainage and if edge maceration is present in addition to the severity of edema. Debride the wound with a curette or scalpel and determine if moisture needs to be

removed aggressively (with an alginate) or maintained (with a hydrogel). If the wound is infected, obtain cultures and prescribe topical or oral antibiotics as appropriate. Apply a compression wrap from the midfoot to upper calf to help control edema.

Initial workup should include venous reflux ultrasound to assess for deep or superficial venous reflux. If venous reflux is present, endovenous sclerotherapy may be warranted. If the wound is adjacent to varices, periwound variceal sclerosis may help. However, if the patient has concomitant arterial disease that may require a bypass graft using the saphenous vein, the great saphenous vein should be preserved. In these cases, consultation and input from a vascular or general surgery colleague would be invaluable (**Figure 4**).

On subsequent visits, pay close attention to the wound size, as these patients often have a waxing-and-waning treatment course. Continuously reassess wound drainage and ensure the dressings applied maintain appropriate moisture balance; changing the types of dressings used every few weeks is not unusual. Also consider prescribing compression stockings, which come in various grades and can be used with great success. However, do not prescribe compression stockings if mixed arterial and venous disease is suspected and the ABI is less than 0.70, as this may compromise any remaining arterial supply. If the patient is unable to tolerate or even put on compression stockings, resumption of wraps, use of lighter compression gradings, or ensuring family assistance and home nursing may be needed. For patients who cannot tolerate standard aggressive long-term compression therapy once wounds are healed, there are other types of compression that may be more tolerable, such as Velcro closure garments or zipper-based stockings.

Of note, venous wounds may have some component of lymphatic disease. Referral to a physical therapy clinic for lymphatic massage or an at-home lymphatic pump may be necessary. While not commonly performed, surgical treatment for severe lymphatic disease such as lymphaticovenous anastomosis[37] may be necessary if the aforementioned strategies fail to help.

Conclusion

Treating chronic wounds is often a multifactorial, multidisciplinary effort. Accurately characterizing a wound can provide insights into the underlying etiology and help monitor treatment response. Treatment and healing may follow a waxing-and-waning course. Therefore, knowledge of the different wound care supplies available will inevitably help providers pivot their treatment strategy when healing has stalled. In addition to treating the underlying etiology of the chronic wound, continual reassessment of underlying comorbidities, nutrition, smoking status, wound infection, and adherence to dressing changes will help troubleshoot stalled wound healing.

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The authors report no financial relationships or conflicts of interest regarding the content herein.

Manuscript accepted April 14, 2025.

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