Diabetic Foot Ulcers

Here's an update on one of the most dangerous conditions treated by podiatrists.

BY WINDY COLE, DPM

Goals and Objectives

After reading this article the podiatric physician will be able to:

1) Recognize the severity of the diabetes epidemic in the podiatric patient population

2) Learn about the best practices for diabetic foot ulcers

3) Become competent in clinical decision-making and charting diabetic foot ulcers appropriately

4) Become familiar with effective wound healing techniques

5) Denote the differences among wound care products

6) Understand the importance of an integrated wound care approach

7) Successfully incorporate diabetic foot wound care strategies to achieve optimal healing for patients

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*Following this article, an answer sheet and full set of instructions are provided (pg. 164).—**Editor***

Characteristics and Causes

Diabetes affects 29.1 million Americans and this number is on the rise. Diabetics have a 25% lifetime incidence of foot ulcers with a 28-51% five year recurrence rate.[1] Diabetes mellitus is a metabolic disease characterized by impaired glucose metabolism resulting in higher than normal glucose levels in the body. This condition occurs due to cells failing to produce insulin or lacking the response to insulin, or both. High blood glucose levels have been attributed to damage of neurons, causing a decrease in the ability of nerve fibers to transmit adequate signals.[2] The paucity of properly functioning nerve fibers may result in lack of sensation in these patients, resulting in a condition referred to as sensory neuropathy. Damage to nerve fibers can also result in autonomic neuropathy, which interferes with the body's ability to regulate involuntary functions such as sweating and blood flow, especially in the lower extremity.

Diabetics have a 25% lifetime incidence of foot ulcers with a 28-51% five year recurrence rate.[1]

High glucose levels can eventually result in weakening of the walls of small blood vessels, impairing

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their ability to deliver essential components such as oxygen and nutrients to distal tissues. The etiology of diabetic foot ulcers usually is multifactorial.[3-5] The vast majority of diabetic foot ulcers can be directly attributed to the debilitating triad of peripheral neuropathy, vascular compromise, and increased plantar pressures due to structural deformities. Although infection is not commonly an etiology in diabetic foot ulcers, it is a common occurrence because these wounds typically contain areas of necrosis, increased bioburden, and are prone to bacterial contamination due to the immunocompromised state of the patient.[3-5] These risk factors for foot ulcers are also predisposing components leading to amputations. 85% of all amputations are a direct result of diabetic foot ulcers.[1]

Steps to Diagnosis

A thorough evaluation of the patient with any ulceration is crucial and will often aid in directing the care and management of these wounds. It is essential to adequately describe the ulcer characteristics such as size, depth, appearance of the wound base, and presentation of the periwound skin, as well as ulcer location. These observations serve as an essential guide to track wound progress during healing. The etiology of the wound is also an essential component in formulating an effective healing plan for these patients. It is important to determine if these lesions are simply neuropathic, ischemic, or neuro-ischemic. A Semmes-Weinstein 10g monofilament is an inexpensive and repeatable instrument that can be utilized to measure diminishing cutaneous sensation. To maximize the diagnostic value of the monofilament evaluation, a systematic three-site test composed of the plantar aspects of the great toe, the third metatarsal, and the fifth metatarsal should be used.[6]

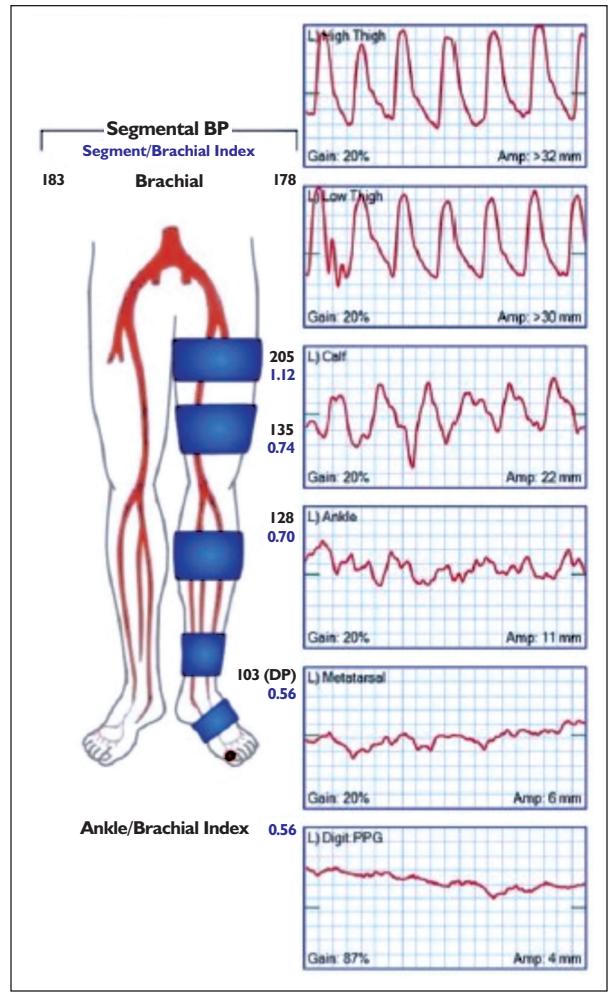

Figure 1: Ankle Brachial Index (ABI)

The vast majority of diabetic foot ulcers can be directly attributed to the debilitating triad of peripheral neuropathy, vascular compromise, and increased plantar pressures due to structural deformities.

A tuning fork and neurologic hammer are also useful tools in determining the level of protective sensation in these patients. Decreased vascular perfusion potentiates a poor prognosis for healing of these wounds. Diminished or absent palpable pedal pulses are a common finding in diabetics because of the involvement of peripheral arterial disease found in the tibial arteries below the knee.[7] Non-invasive arterial Doppler studies should be utilized in evaluation of vascular perfusion. Obtaining an ankle brachial index (ABI) reading to determine vascular perfusion in the affected extremity is a very helpful value. An ABI is performed by measuring blood pressure at the ankle and the arm while the patient is at rest. A normal ABI is 1.0-1.4. Abnormal values below 0.9 indicate that there is a higher chance of having peripheral arterial disease (Figure 1).[8] Pulse volume recordings (PVRs) of the digits are also a powerful tool in ascertaining distal perfusion. A timely vascular surgical consultation is essential when there is significant suspicion of ischemia.

Systemic Markers

Systemic markers of diabetic disease are important to notate and follow in these patients. Hemoglobin A1C is a useful lab value to determine the long-term effectiveness of the patient's glucose control. This lab value measures the level of blood glucose over the past three months. The normal range of A1C is 4-5.6%. Optimization of this marker can be essential for healing in diabetic wounds. BUN and creatinine levels should also be evaluated to identify patients at risk for chronic kidney disease. Kidney disease is associated with a fourfold higher risk of diabetic foot complications such as infection, ulcer, gangrene, or amputation.[9]

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Patients with co-existing diabetes and kidney disease are 10 times greater than in the general diabetic population to have a lower extremity amputation.[10] Vascular insufficiency is three times more prevalent in individuals with kidney disease, and the severity of peripheral vascular disease worsens with increased severity of kidney disease.[11] Albumin and pre-albumin values can help assess nutritional deficits in the patient. This is an often overlooked but essential part of the healing cascade. Wound healing requires 30-35 kcal/kg a day to optimize healing.[12] Identifying these patients and subsequent recommendation of proper referrals for nutritional management can then be instrumental in potentiating healing.

Examination

Examination of an ulceration should include not only obtaining measurements of length, width, and depth, but also probing the wound base and circumference with a blunt sterile instrument. Gentle probing of the area can detect sinus track formation, undermining of ulcer margins, and expose deep tissue structures such as tendons, muscle, and bone. A positive probe to bone finding has been associated with an increased predictive value for osteomyelitis.[13] Don't overlook the importance of evaluating wound drainage to include the amount, color, and any associated odor present. The presence and extent of cellulitis, abscess, or fluctuance around the wound should be noted. In cases where cellulitis extends beyond 2cm from the ulcer perimeter, large abscess formation is present, or markers of osteomyelitis as exposed bone are noted, a limb-threatening infection is present.[14]

In such cases, aerobic and anaerobic cultures should be obtained. Polymicrobial infections predominate diabetic foot wounds and therefore, culturing non-infected wounds is not recommended. Cultures of deep purulent discharge or curetted material from the wound base with clinical suspicions of infection are optimal. Radiographs should be obtained in most instances of recalcitrant long-standing ulcerations to screen for osteomyelitis. Delays in diagnosing osteomyelitis often cause failure of wound healing. Radiographs are not the most sensitive indicator of bone infection and can be falsely positive in the presence of Charcot's arthropathy.

Nutritional deficits can effect wound healing and need to be bothered screening for.

In cases where clinical suspicion suggests osteomyelitis, bone leukocyte scanning or magnetic resonance imaging are more specific screening tools.[15] Appropriate referrals to infectious disease specialists for intravenous antibiotic management, hyperbaric oxygen therapy, and surgical interventions may be employed to treat osteomyelitis when present.

Wound Classification

Utilizing classification systems in medical conditions is a useful method for aiding in the formulation of a logical treatment plan and can serve as a good predictor of clinical outcomes. The most widely accepted classification system for diabetic foot ulcers is the Wagner classification system (Figure 2). The basis of this system is the extent of the wound depth and the extent of tissue necrosis.

Documentation and Coding

Documentation of diabetic wounds should always include wound measurements upon presentation at every wound care visit. If a debridement is performed, the type of debridement, instrument used, depth of tissue removed, character of the wound bed pre- and post-debridement, amount of bleeding that occurred, how the patient tolerated the procedure, and the post-debridement wound measurements must all be recorded. As was mentioned earlier, drainage amount, character, and odor are also essential notable findings.

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FIGURE 2:

Wagner Ulcer Classification System

Grade	Lesion
0	No open lesions; may have deformity or cellulitis
1	Superficial diabetic ulcer (partial or full thickness
2	Ulcer extension to ligament, tendon, joint capsule, or deep fascia without abscess or osteomyelitis
3	Deep ulcer with abscess, osteomyelitis, or joint sepsis
4	Gangrene localized to portion of forefoot or heel
5	Extensive gangrenous involvement of the entire foot

Figure 2: Wagner DM Foot Ulcer Classification

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The peri-wound skin appearance should be evaluated and recorded.

Presence of edema, erythema, color changes, and skin temperature should be mentioned within the chart, as well. When concomitant structural deformities such as hammertoes or bunions are present and are contributing factors to the development or delay in healing of the wound, they need to be fully described and addressed. Neurovascular assessments should be performed regularly to grade and monitor neuropathy and vascular perfusion.

When choosing codes for diabetic wounds, it is imperative that the diagnosis of diabetes is primary. Wound etiologies such as pressure, trauma, and/or vascular insufficiency can also be used, but should be notated secondary to the diagnosis of diabetes. The specificity of ICD-10 requires codes to be used to determine laterality of the wound, location of the wound, and the specific depth of the wound. Steer clear of any codes containing the wording of 'unspecific'. These codes should not be chosen as they will be inadequate for insurance reimbursement. Establishing the primary etiology of the wound as diabetic in nature can allow for the use of certain adjunctive therapies such as cellular and tissue products or hyperbaric oxygen therapy, should the need arise.

Standard of Care

The primary goal in wound care is not for the technical repair of the wound, but to provide the optimal conditions for the natural healing process of wound reparation to proceed. By approaching the treatment of diabetic foot wounds in a stepwise fashion, healing potential will be optimized. The treatments employed during the course of wound care will largely depend on the grade of the wound, its vascularity, and the presence and severity of infection. It is imperative to approach treatment of diabetic foot wounds with a multidisciplinary care team. These are complicated wounds with multiple etiologies, and numerous co-morbidities can exist in these patients.

Examination of an ulceration should include ulcer length, width and depth.

Relief of Pressure

Relief of pressure from the area of the wound is the single most important issue that should be addressed upon first presentation. Plantar foot ulcers typically result as a consequence of abnormal foot pressures and repetitive moderate stress encountered by the neuropathic foot while ambulating.[16] Footwear needs to be evaluated, and ill-fitting shoes must be replaced. If the diabetic wound is on the plantar surface of the foot, some type of pressure-relieving footwear, removable walking boot, or total contact cast to off-load pressure from the foot should be employed (Figure 3).

Figure 3: Total Contact Cast (TCC)

A crucial part of treatment of diabetic foot wounds is regular debridement. 17) The goal of debridement is the removal of all necrotic, fibrous, and devitalized tissue from the wound bed. It is recommended that unhealthy tissue be sharply debrided to bleeding tissue in order to allow for visualization of the extent of the ulcer and to detect underlying exposed structures or abscesses. If sharp debridement cannot be performed due to increased pain or patient objection, enzymatic, mechanical, biological debridement, or other tissue-removing wound products can be employed (Figure 4).

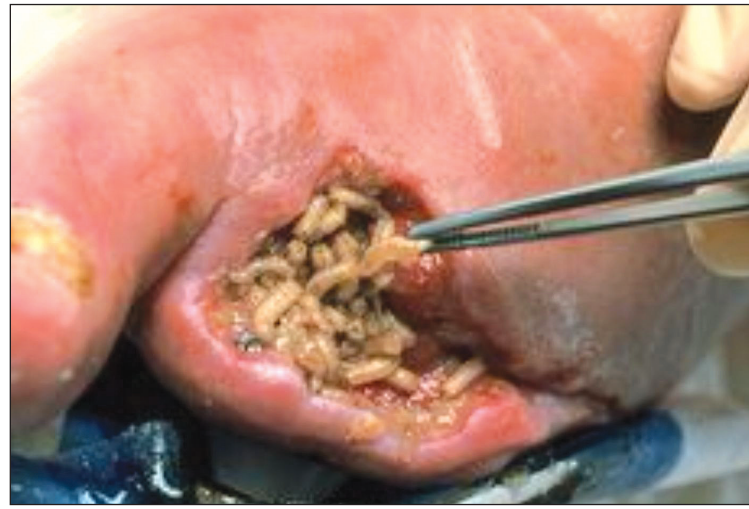

Figure 4: Maggot (biological) Debridement

If ischemia exists, it is imperative to optimize perfusion to achieve a successful outcome, regardless of topical therapies

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used. Appropriate vascular and surgical consultations should be obtained when a patient presents with an ischemic ulcer, an abnormal ABI reading is obtained, or a wound fails to progress despite appropriate wound management. Often patients with diabetic foot ulcers need to undergo distal arterial reconstruction to restore adequate blood flow into the limb.

Working closely with a vascular surgeon who performs these revascularization procedures allows for more aggressive foot-sparing treatments and interventions to be undertaken. Hyperbaric oxygen therapy has been used as an adjunctive therapy in diabetic foot wounds demonstrating decreased perfusion. The oxygenation of hypoxic tissue is one of the mechanisms by which HBOt can help accelerate wound healing. Studies have shown that over time, HBOt oxygenation of chronic wounds can promote significant neovascularization in as little as 14 treatments (Figure 5).[18]

Relief of pressure from the area of the wound is the single most important issue that should be addressed upon first presentation.

Antibiotic Therapy

When clinical signs of infection are present, proper antibiotic therapy should be initiated. Aerobic and anaerobic cultures should be obtained to effectively choose the appropriate antimicrobial agent. Moderate to severe diabetic foot infections are oftentimes complicated by underlying abscess or osteomyelitis. Deep abscesses may require hospitalization and surgical drainage. When osteomyelitis is advanced, aggressive bone resection followed by four to six weeks of culture-specific antibiotics should be initiated. Obtaining proper infectious disease consultations, especially when intravenous antibiotics will be utilized, is a common practice when treating severe diabetic foot wounds complicated by abscess and osteomyelitis. Increasing tissue oxygenation with HBOt can accentuate macrophage phagocytosis and increase the effectiveness of bacterial-killing polymorphonuclear cells.[19] Increasing the concentration of oxygen by using HBOt has also been shown to inhibit bacterial growth and potentiate the effectiveness of antibiotic therapy.[20]

The primary goal in wound care is to provide the optimal conditions for the natural healing process to occur.

Other Considerations

Prevention of recurrent diabetic foot wounds is the key to amputation prevention. A multidisciplinary approach to prevention has been shown to dramatically reduce the rate of lower extremity amputations and speed ulcer healing rates.[21] Primary care physicians, doctors of internal medicine, podiatrists, and pedorthists all play an important role. Patient education is paramount. Instruction should include diabetes disease management, proper foot hygiene and inspection, use of appropriate footwear, and the need to seek prompt treatment for any newly-developed lesions. Regular glucose monitoring and foot exams allow clinicians to closely track the progression of diabetes and provide opportunities to reinforce current treatments as well as detect new or impending problems.

Therapeutic Shoes

Therapeutic shoes coupled with pressure-relieving multi-density insoles have been associated with a significant decrease in development of diabetic foot ulcerations.[22] It is the author's current practice

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Figure 5: Hyperbaric Oxygen Chamber

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to have a local pedorthist come into the wound clinic two to three weeks prior to ulcer healing. At this point in time, the process of measuring for accommodative footwear is begun. This allows for direct transfer of the patient into the completed diabetic footgear directly upon healing (Figure 6).

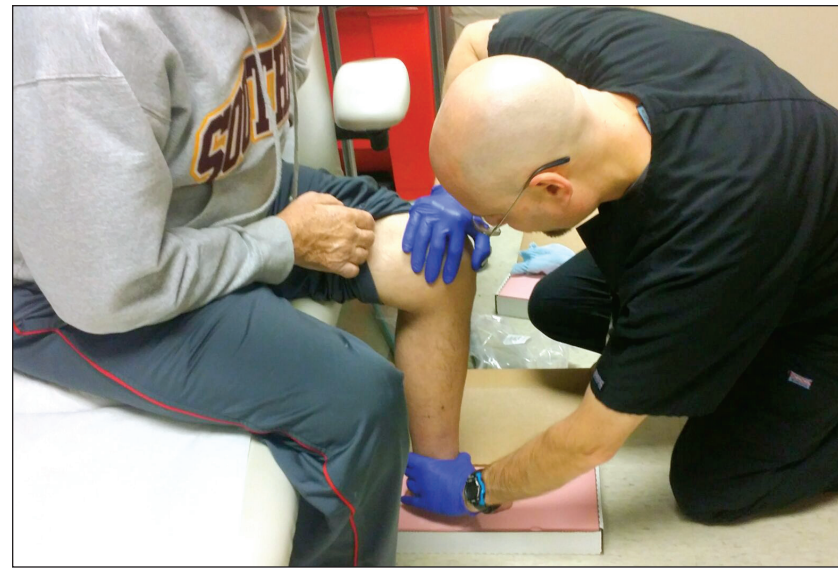

Figure 6: Pedorthic shoe fitting

Conclusion

Diabetes is a complicated disease with many serious sequelae. Development of foot ulcerations are very common in patients with diabetes. These patients often fail to detect foot ulcerations until they become large and/or infected. These ulcerations can deteriorate quickly due to the multiple co-morbidities found within this patient population. Prompt and aggressive wound care is key to successful treatment of diabetic foot wounds. Wound healing centers with rigorous and proven protocols to manage these types of ulcerations are the cornerstone of therapy. Controlling infection, maximizing perfusion, regulation of diabetes, and proper off-loading are all essential components needed for healing these difficult wounds. Wound healing centers take the multidisciplinary approach shown to be the hallmark of successful treatment of the diabetic patient. The focus should be on education. An informed patient makes for a more compliant patient. Repeated education of diabetic patients has shown a reduction in amputation rates by 50% or more.[23] PM

Prevention of recurrent diabetic foot wounds is the patient's responsibility.

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CME EXAMINATION

SEE ANSWER SHEET ON PAGE 165.

1) Which is a true statement regarding diabetic foot ulcers?

A) They affect millions of Americans.
B) The frequency is on the rise.
C) Diabetic foot ulcers have a high recurrence rate.
D) All of the above.

2) The etiology of diabetic foot ulcers include which of the following?

A) Increased vascularity to the feet.
B) Peripheral neuropathy
C) Decreased plantar foot pressures.
D) A non-immunocompromised state.

3) What would be an important step in diagnosing and treating a diabetic foot ulcer?

A) Adequately describing the ulcer characteristics such as size, depth, appearance of the wound base
B) Ignoring the etiology of the wound because it has no effect on the treatment plan for these patients
C) Determining if the ulcer is simply neuropathic, ischemic, or neuro-ischemic
D) Both A and C

4) All statements about the work-up of diabetic foot ulcer patients are true except:

A) Obtaining an ankle brachial index (ABI) reading to determine vascular perfusion in the affected extremity is a very helpful value.
B) Hemoglobin A1C is a useful lab value to determine the long-term effectiveness of the patient's glucose control.
C) BUN and creatinine levels should also be evaluated to identify patients at risk for chronic kidney disease.
D) Nutritional deficits have no effect on wound healing and do not need to be bothered screening for.

5) Examination of an ulceration should include obtaining measurements of the following:

A) Length of time of debridement.
B) Ulcer length, width and depth.
C) Number of steps it takes the patient to get to the restroom.
D) No measurements need to be taken on a diabetic foot wound exam.

6) All of the following are considered true regarding documentation of diabetic wounds except:

A) If a debridement is performed, the type of debridement, instrument used, depth of tissue removed.
B) The character of wound bed pre- and post-debridement, amount of bleeding that

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occurred, how the patient tolerated the procedure.
C) Drainage amount, character, and odor are notable findings.
D) Including a wound photo in the chart is all that is needed for documentation.

7) The primary goal in wound care is to:
A) Facilitate the technical repair of the wound.
B) Use as many high-cost products as possible.
C) Provide the optimal conditions for the natural healing process to occur.
D) Prolong the patient's healing so they need to make more appointments.

8) What is the single most important issue that should be addressed upon first presentation?
A) All medications that the patient is on
B) Relief of pressure from the area of the wound.
C) Who was the referral source of the patient?
D) What type of insurance coverage the patient has.

9) A crucial part of the successful treatment of diabetic foot wounds includes:
A) Regular debridement
B) Optimizing perfusion
C) Controlling infection
D) All of the above.

10) Prevention of recurrent diabetic foot wounds is:
A) Not at all important
B) Impossible to achieve
C) The key to amputation prevention
D) The patient's responsibility

SEE ANSWER SHEET ON PAGE 165.

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Diabetic Foot Ulcers
(Cole)

Circle:

1.	A	B	C	D	6.	A	B	C	D
2.	A	B	C	D	7.	A	B	C	D
3.	A	B	C	D	8.	A	B	C	D
4.	A	B	C	D	9.	A	B	C	D
5.	A	B	C	D	10.	A	B	C	D

Medical Education Lesson Evaluation

Strongly agree [5]	Agree [4]	Neutral [3]	Disagree [2]	Strongly disagree [1]

1) This CME lesson was helpful to my practice ____

2) The educational objectives were accomplished ____

3) I will apply the knowledge I learned from this lesson ____

4) I will makes changes in my practice behavior based on this lesson ____

5) This lesson presented quality information with adequate current references ____

6) What overall grade would you assign this lesson?

A B C D

7) This activity was balanced and free of commercial bias.

Yes _____ No _____

8) What overall grade would you assign to the overall management of this activity?

A B C D

How long did it take you to complete this lesson?

_____hour _____minutes

What topics would you like to see in future CME lessons ? Please list :

_____

_____

_____

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