PATHWAY #2

DIABETIC PERIPHERAL ARTERIAL DISEASE

SIGNIFICANT HISTORY
- Rest Pain
- Previous ulceration or infection
- Claudication
- Smoker
- Metabolic syndrome

SIGNIFICANT FINDINGS
- Examination
  - Dermatologic: trophic changes, ulcer, gangrene
  - Vascular: Poor or non-palpable pedal pulses
- Clinical Maneuvers
  - Elevation pallor
  - Dependent rubor

DIABETES PAD

INVASIVE VASCULAR STUDIES
- Arteriogram, DSA
- CT angiogram, MRA

Medical Management
- Antilipemic agents (statins)
- Antiplatelet therapy
- Vasodilators

Revascularization
- Angioplasty
- Endovascular
- Open bypass grafting

Follow-Up
- Patient education
- Smoking cessation
- Protective shoes
- Periodic foot care
- Reconstructive foot surgery as needed

Noninvasive Vascular Studies
- Arterial Doppler: waveforms, ABIs & toe pressures,
- Transcutaneous oxygen tensions

Gangrene or extensive tissue loss in face of unreconstructable PAD
- Consider amputation
Neurologic Evaluation

Peripheral sensory neuropathy is the major risk factor for diabetic foot ulceration (24, 26, 27, 46, 50). The patient history and physical examination utilizing the 5.07 Semmes-Weinstein monofilament (10-g) wire are sufficient to identify individuals at risk for ulceration (26, 232-235).

Vibration perception threshold assessment with the biothesiometer is also useful in identifying patients at high risk for ulceration (44, 57, 236). More sophisticated studies such as nerve conduction studies are rarely necessary to diagnose peripheral sensory neuropathy. Patients with neuropathic ulcerations usually have such profound sensory neuropathy that these studies add little to their clinical management (49).

Plantar Foot Pressure Assessment

High plantar foot pressure is a significant risk factor for ulceration (26, 45, 59, 70, 76, 80, 237). Measurement of high plantar foot pressure is possible utilizing a variety of modalities. Several computerized systems can provide quantitative measurement of plantar foot pressure (76, 81, 238-241). While these measurements may be important in identifying areas of the foot at risk for ulceration and possibly in evaluating orthotic adjustments (57, 59), they are primarily used in diabetic foot research. The Harris mat, while not as sophisticated, can provide a qualitative measurement of plantar foot pressures and can identify potentially vulnerable areas for ulceration (242). A newer noncomputerized device (PressureStat®, FootLogic, New York City, NY), which is similar to the Harris mat and uses pressure-sensitive contact sheets that provide a semi-quantitative estimation of pressure distribution under the foot, has been suggested as an inexpensive screening tool for identifying areas at high risk for ulceration (76, 243).

Risk Stratification

Following a thorough diabetic foot examination, the patient may be classified according to a cumulative risk category. This enables the physician to design a treatment plan and determine whether the patient is at risk for ulceration or amputation. Several risk stratification schemes have been proposed, assigning different weights to important risk factors for ulceration including peripheral neuropathy, arterial insufficiency, deformity, high plantar pressures, and prior history of ulceration or amputation (48, 57, 62, 90, 244-246). Although no one system has been universally adopted to predict complications, Table 4 presents a simplified risk stratification that has been endorsed by an international consensus group and others (90, 247).

THE HEALTHY DIABETIC FOOT: PREVENTION STRATEGIES

A healthy, intact diabetic foot is best maintained by a consistent and recurrent preventive treatment strategy (2, 30, 43, 48, 90, 163, 246, 248). This is best accomplished through a multidisciplinary approach involving a team of specialists and personnel who provide a coordinated process of care (Fig 5). Team members may include a podiatrist, internist, ophthalmologist, endocrinologist, infectious disease specialist, cardiologist, nephrologist, vascular surgeon, orthopedic surgeon, nurse (educator, wound care, and home care), and pedorthist/orthotist.

Patient and family education assumes a primary role in prevention. Such education encompasses instruction in glucose assessment, insulin administration, diet, daily foot inspection and care, proper footwear, and the necessity for prompt treatment of new lesions (163, 174, 249-251). Regularly scheduled podiatric visits, including debridement of calluses and toenails, are opportunities for frequent foot examination and patient education (163, 252). Such visits can provide early warning of impending problems and subsequent modification of activity and care (30, 253).

Diabetes is a lifelong problem, and the incidence of diabetic foot complications increases with age and dura-

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<table>
<thead>
<tr>
<th>Table 4</th>
<th>Risk Categorization System</th>
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<tbody>
<tr>
<td>Category</td>
<td>Risk Profile</td>
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<tr>
<td>0</td>
<td>Normal</td>
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<tr>
<td>1</td>
<td>Peripheral neuropathy (LOPS)</td>
</tr>
<tr>
<td>2</td>
<td>Neuropathy, deformity and/or PAD</td>
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<tr>
<td>3</td>
<td>Previous ulcer or amputation</td>
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</table>
A diabetic foot service is composed of a variety of specialists generally needed to evaluate and treat the pathology seen in the patient with diabetes. Effective management must include appropriate consultation for treatment of known comorbidities. Studies support the efficacy of protective footwear in this regard, two reports suggest that shoes in the absence of a comprehensive prevention program might not be sufficient to prevent new lesions (263, 264). Nevertheless, patients with foot deformities that cannot be accommodated by standard therapeutic footwear should have custom shoes that provide appropriate fit, depth, and a rocker insole (260, 265-269). If structural deformities cannot be accommodated by therapeutic footwear, prophylactic surgical correction should be considered, but patients must be carefully selected (173, 255, 270-273).

Diabetic patients at risk for foot lesions must be educated about risk factors and the importance of foot care (48, 274-276), including the need for self-inspection and surveillance, monitoring foot temperatures, appropriate daily foot hygiene, use of proper footwear, good diabetes control, and prompt recognition and professional treatment of newly described ulceration of the disease. A recent Markov analysis of the cost effectiveness of foot care according to published guidelines found that such preventive care can improve survival, reduce ulceration and amputation rates, is cost-effective, and can even save on long-term costs when compared with standard care (254).

Risk stratification based on the presence of predisposing causal risk factors, including prior history of ulceration, also serves as a guide to the frequency of foot care visits. By identifying high-risk patients and tailoring a total foot care prevention program accordingly, the incidences of ulceration and lower extremity amputations can be reduced (253, 255-258).

Therapeutic shoes with pressure-relieving insoles and high toe boxes are important adjunctive treatments that can reduce the occurrence of ulceration and resultant amputation in high-risk patients (51, 86, 259-262). While most studies support the efficacy of protective footwear in this regard, two reports suggest that shoes in the absence of a comprehensive prevention program might not be sufficient to prevent new lesions (263, 264). Nevertheless, patients with foot deformities that cannot be accommodated by standard therapeutic footwear should have custom shoes that provide appropriate fit, depth, and a rocker insole (260, 265-269). If structural deformities cannot be accommodated by therapeutic footwear, prophylactic surgical correction should be considered, but patients must be carefully selected (173, 255, 270-273).

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covered lesions. Home temperature assessment of the foot has been shown to reduce the incidence of foot ulcers 10-fold compared with standard preventive care (277). Patients with visual or physical impairments that preclude their own care should engage the assistance of family or friends to aid in this regard (275). When combined with a comprehensive approach to preventive foot care, patient education can reduce the frequency and morbidity of limb threatening diabetic foot lesions (274, 278, 279).

Provider education is equally important in prevention, since not all clinicians are cognizant of important signs and risk factors for pedal complications (163, 174, 276). Furthermore, provider education is effective in reinforcing proper diabetes management and foot care practices, resulting in reductions in ulceration and adverse lower extremity outcomes (48, 276, 280-282).

**PATHOLOGIC ENTITIES OF THE DIABETIC FOOT (Foot Ulcer, Infection, Charcot Foot)**

Effective management of diabetic foot disorders requires knowledge of the potential pathologies, the associated classification systems, and the principle tenets of intervention. Ulceration, infection, and Charcot arthropathy are the most significant of these pathologies and classification systems have been developed for each entity. While the conditions may be seen either as an isolated event or coexisting in the same extremity, each entity is examined independently in this clinical practice guideline.

**DIABETIC FOOT ULCERS (Pathway 3)**

**Evaluation of Ulcers**

The initial evaluation of the diabetic foot ulcer must be comprehensive and systematic to ascertain the parameters that might have led to its onset as well as determine the presence of factors that can impair wound healing (25, 52, 54). Critical in this regard are assessments for vascular perfusion (ischemia), infection/osteomyelitis, and neuropathy. As previously discussed, a thorough vascular evaluation must be performed; this includes palpation of pulses, clinical evaluation of capillary filling time, venous filling time, pallor on elevation, and dependent rubor (283). If pulses are not palpable or if clinical findings suggest ischemia, noninvasive arterial evaluation (eg, segmental Doppler pressures with waveforms, ankle brachial indices, toe pressures, TcPO2 measurements) and vascular surgical consultation are warranted. When required, these physiologic and anatomic data can be supplemented with the use of magnetic resonance angiography (230) or CT angiography (CTA) and subsequent use of arteriography with digital subtraction angiography (DSA) as necessary (77, 89, 284).

Description of the ulcer characteristics on presentation is essential for the mapping of the ulcer’s progress during treatment (30, 43). While some characteristics are more important than others, they all have prognostic value during management. The presumed etiology of the ulcer (ie, chemical vs mechanical) and character of the lesion (neuropathic, ischemic, or neuroischemic) should be determined (90). The evaluation should also describe the size and depth of the ulcer as well as the margins, base, and geographic location on the extremity or foot. All but the most superficial ulcers should be examined with a blunt, sterile probe. The description should note whether the sterile probe detects sinus tract formation, undermining of the ulcer margins, or dissection of the ulcer into tendon sheaths, bone, or joints. A positive probe to bone (PTB) finding is highly predictive of osteomyelitis, although the frequency of false-negative tests reduces its sensitivity (119, 123, 285). Perhaps most importantly, the positive predictive value for PTB falls off significantly when the prevalence of osteomyelitis decreases (286).

The existence and character of odor or exudate should be noted. Cultures may be necessary when signs of inflammation are present. Generally, clinically uninfected ulcers without inflammation should not be cultured (30, 123). Current recommendations for culture and sensitivity include thorough surgical preparation of the wound site with curettage of the wound base for specimen or with aspiration of abscess material (30, 287).

**Classification of Ulcers**

Appropriate classification of the foot wound is based on a thorough assessment. Classification should facilitate treatment and be generally predictive of expected outcomes. Several systems of ulcer classification are currently in use in the US and abroad to describe these lesions and communicate severity (62, 90, 288-292). Perhaps the easiest system is to classify lesions as neuropathic, ischemic, or neuroischemic, with descriptors of wound size, depth, and infection (90). Regardless of which system is used, the clinician must be able to easily categorize the wound and, once classified, the ensuing treatment should be directed by the underlying severity of pathology.

Although no single system has been universally adopted, the classification system most often used was described and popularized by Wagner (292). In the Wagner system (Table 5), foot lesions are divided into six grades based on the depth of the wound and extent of tissue necrosis. Since these grades fail to consider the important roles of infection, ischemia, and other comorbid factors, subsequent authors have modified the classification system by including