Foot Care for Patients With Diabetes

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As the rate of patients developing diabetes and prediabetes increases, the risk of developing ulcerations leading to amputation increases. The incidence of open wounds in patients with diabetes is very high and affects 1 of every 6 patients. These nonhealing “diabetic ulcers” are the major cause of leg, foot, and toe amputations. The ulcers do not occur spontaneously but are always preceded by a gradual or sudden injury to the skin by some external factor. Preventing these types of injuries, and early recognition when they do occur, can reduce the risk of the wound progressing to the point of amputation. Healthcare providers play an important role in recognizing the early signs of changes in the feet. Early patient education has been proven to be beneficial in identifying these changes that are brought about as a result of diabetes and, by doing so, reducing the risk of complications. This article reviews the typical changes that may occur in the feet of patients with diabetes and discusses how early recognition and prevention can assist in reducing the complications that occur as a result of ulcerations. Key words: diabetes, foot care, neuropathic ulcers

PREVALENCE AND RISK FACTORS

More than 5 million people in the United States are at risk for diabetes-related problems. People with diabetes spend more time in the hospital for treatment of foot problems related to diabetes than for any other reason. Approximately 15% of individuals with diabetes have had an ulcer on the foot or ankle. Diabetes is estimated to be the primary causative factor in 45% of all lower extremity amputations, with 60% of nontraumatic amputations being the result of long-term complications of diabetes. This percentage increases the longer one has had diabetes. In one Health Maintenance Organization review, 5.8% of all patients with diabetes had neuropathic ulcerations, with 15% developing osteomyelitis. The 3-year survival rate of those developing the ulcerations was 13% less than for those without ulcers. In 2000, the age-adjusted rate of lower extremity amputations among American Indians was found to be 3.5 times higher than the non-Hispanic white population. The incidence of lower extremity amputation was also twice as high for men as for women and increased with age. Amputation is found to be a much higher cost to the health system because of the multiple and prolonged hospitalization than the lower cost of prevention or the multidisciplinary approach to care of patients with diabetes and related ulcers. A study by Al-Tawfiq and Johndrow in Saudi Arabia concluded that patients with diabetic foot ulcers require aggressive management to reduce morbidity and mortality associated with major amputations in patients with diabetes... and preventative measures for developing diabetic foot ulcers are needed for those patients identified to be at high risk for foot ulcerations.

Neuropathy is the greatest risk factor for ulceration in patients with diabetes. There are several types of neuropathy that lead to structural and pathological changes of the foot, resulting in an increased risk for ulceration and amputation. Early recognition of the symptoms of neuropathy is important because these may precede the onset of blood
FOOT CARE FOR PATIENTS WITH DIABETES

Glucose abnormalities. These include sensory, motor, and autonomic neuropathies. Sensory neuropathy is seen as impaired sensation in the hands and feet. Nearly 50% of all persons with diabetes have lost the ability to feel pain, heat, or cold and the sense of touch. The patient may complain of paresthesias in a stocking-like distribution and/or superficial or deep shooting pain. There is a loss of vibration sense, proprioception, light touch, and eventually a loss of pain sensation. This leads to a totally insensitive foot and can progress to neuropathic arthropathy (Charcot foot).

Motor neuropathy changes include muscle weakness and wasting of the intrinsic muscles of the foot. With a flexor-extensor muscle imbalance, there is a dorsal subluxation of the digits. This change in structure results in abnormal weight bearing on the metatarsal heads, which leads to ulcerations. Autonomic neuropathy changes are seen as decreased perspiration, dryness and fissuring of the skin, and a loss of microcirculation. Eighty percent of those with a diagnosis of diabetes have some form of neuropathy and often a combination of several types of neuropathy. Severe forms of neuropathy are the major contributing cause of lower extremity ulcerations and amputations. The more accurate term for these neuropathic ulcerations is mal perforans ulcer.

EFFECT OF DIABETES ON THE FEET

People with diabetes experience higher than normal blood glucose concentrations as well as damage to small blood vessels, which can result in damage to the nerves in the foot and leg, decreasing the ability to feel injuries. The motor nerves that control the shape of the foot are also damaged, resulting in deformities of the bony prominences such as the interphalangeal joints, tips of the toes, heel, and the arch and ball of the foot. These bony prominences may be continually rubbed or pressed by shoes causing skin injuries through mechanical forces. The elevated blood glucose levels can impair the circulation of the blood vessels that supply the skin. When there is a skin injury, the body requires 50 times the normal blood flow to heal. When the circulation is already impaired as a result of the elevated blood glucose levels, the resultant blood flow required for healing is unavailable, so the skin injury will deteriorate resulting in a worsening of the wound and increasing the risk of a rapid onset of infection.

FOOT CHANGES

Structural

Along with the nerve damage that can change the shape of the feet and toes, muscle atrophy can occur resulting in biomechanical changes leading to abnormalities in gait and balance. Injuries can occur as a result of these structural changes. Common structural changes include pes equinus, hallux limitus/rigidus, hallux valgus, hammer toes, varus deformities of the toes, and tailor’s bunion on the fifth metatarsal. A series of fractures to the bones, ankle equinus, decreased sensation, and increased blood flow to the bone can result in demineralized bone leading to a Charcot foot deformity (Fig 1). Utilizing the Fiess line (a line between the inner apex of the medial malleolus and the head of the first metatarsal) and the relationship between the navicular and this line when the patient is in a weight-bearing position, the structure of the patient’s arch can be determined. This can be documented evidence of progression toward pes planus and need for supportive intervention.

The structural changes that occur with diabetes can affect mobility and balance. A thorough evaluation of gait, balance, and strength through appropriately chosen functional outcome tests will enable the therapist to design appropriate interventions for patients to decrease their fall risk.

Nails/skin

The nerves that control the oil and moisture to the foot become impaired with diabetes. The result is dry skin that may peel and crack. The resultant fissures of dry skin...
are portals to infections.\textsuperscript{13} Skin can become drier with repeated soaking of the feet. Patients should be instructed to avoid soaking the feet and to utilize unscented moisturizers or petroleum jelly applied thinly to the feet but not between toes. Moisturizers between toes can lead to infection.\textsuperscript{14}

Calluses build up more often on the feet of people with diabetes. This is the result of high-pressure areas under the foot as the structure and biomechanics change. Calluses indicate the need for proper fitting shoes with pressure relief. Too often, patients continue to buy the same size shoes year after year, even though their feet are changing. This puts them at risk for developing calluses. Calluses can get thick, break down, and turn into ulcers if not properly trimmed by a healthcare professional (Fig 2). Patients should be instructed to never trim their own callus. They can be taught to properly use a pumice stone after bathing.

**Sensory**

Many sensory changes occur as a result of nerve damage. Patients may complain of paresthesia, describing the sensation as spiders crawling, burning, or electrical charges. Test and measures for the evaluation of sensory changes include a vibration test with a tuning fork. A 128-Hz tuning fork is placed on the great toe, medial malleoli, and tibial tuberosity, with the patient answering yes or no to when he or she feels the vibration and when the sensation stops. Another test is for proprioception, the up-and-down test on the great toe. The most important sensory test for neuropathic ulcers is the testing of protective sensation through the Semmes Weinstein monofilament test (Fig 3). This test is performed by utilizing a 10-g (or 5.07) filament and testing 10 points on the foot: plantar surface of digits 1, 3, and 5; metatarsal heads of digits 1, 3, and 5; medial and lateral arches; heel; and the dorsum of the foot. The score is determined by the number of times the patient did not feel the sensation. An inability to feel any 3 of the sites constitutes a positive test for a foot at risk for ulcerations. These sensory tests identify areas of concern for education on daily foot examinations.

**PREVENTION**

The Centers for Disease Control and Prevention has determined that “regular
foot care can reduce serious foot disease by 50–60% affecting the quality of life of our aging population, and potential benefits to the Medicare/Medicaid programs could be profound. Increasing the proportion of persons with diabetes who receive preventive foot care and reducing lower extremity amputations in the United States were included in the national health objectives for 2010. From 1995 to 2001, the prevalence of annual foot examinations among those with diabetes increased from 56% to 62.3% but was still under the national target of 75%. Many studies have looked at the financial implications of preventive foot care. There is overwhelming evidence that multidisciplinary approach results in a high probability of healing without amputation. The first step to minimize risk of amputation is preventing lesions from developing into gangrene or a deep infection. Risk factors for lower extremity amputation include having had a previous foot ulcer or
amputation. An important part of preventing these lesions is having foot and footwear checks done annually by any healthcare provider who comes in contact with the patient, particularly for those patients with long duration of diabetes who use insulin and those who smoke. Daily foot checks should also be taught to patients and their caregiver. Foot ulcers are usually found to precede amputation and are caused by several underlying problems, including neuropathy and reduced circulation, which lead to injury and poor healing. Identification of risk for amputation is an important component in preventive care (Table 1) The Lower Extremity Amputation Prevention scale is a screening tool that can guide the provider in objectively documenting the required intervention and frequency of foot reassessments. A monofilament kit with a comprehensive guide to foot care is available at no cost from the National Diabetes Education Program of the National Institutes of Health (http://www.ndep.nih.gov/publications/PublicationDetail.aspx?PubId=116) (Table 2).

Preventive strategies for reduction of neuropathic ulcers should include glycemic control, smoking cessation, early detection and appropriate management of those with high-risk foot conditions, provider education, and patient education on proper daily foot care and foot wear. When ulcerations do occur, healthcare interventions should include multidisciplinary approach to foot ulcers and strict amputation criteria. In both cases, long-term follow-up and/or regular screens based on documented criteria are necessary. Provision of integrated foot care management for the person with diabetes has a positive impact on the primary care staffs’ knowledge and patients’ attitudes, resulting in an increased number of appropriate referrals to specialist services. Early intervention has been shown to have the best optimal result in reducing increased infections and amputations.

Table 1. Identification of increased risk of amputation

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>Interventions</th>
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</table>
| 0 | Intact protective sensation  
Yearly follow-up foot screening  
Proper footwear education |
| 1 | LOP  
No foot deformity  
Follow-up every 6 mo  
Patient education |
| 2 | LOP with foot deformity  
Follow-up every 3 mo  
Patient education and skin care |
| 3 | LOP with foot deformity  
History of previous ulceration or amputation  
Follow-up monthly  
Patient education and skin care  
Custom-molded orthotics  
Prescription footwear |

Abbreviation: LOP, loss of protective sensation.
Shoes/footwear

In 1989, a Medicare Therapeutic Shoe Demonstration was begun to determine the cost-effectiveness of using Medicare part B coverage for therapeutic shoes in patients with diabetes who have severe foot disease. Eligible patients had a past or present history of callus formation, with peripheral neuropathy, foot ulceration, prior amputation of a foot in whole or in part, foot deformity with potential for ulceration, or poor circulation. The coverage was limited to one pair of depth-inlay or custom-molded shoes per year. Several follow-up studies showed that the addition of shoes to Medicare part B coverage did not increase the overall cost of the Medicare program. However, only 6% of the physicians who were notified about the Medicare demonstration ever enrolled any patients. Still in 1993, Medicare added coverage of therapeutic shoes for beneficiaries with diabetes at risk for foot disease, and podiatrists were added to the listing of physicians who could certify the need for such shoes. Even with focused education to beneficiaries and physicians, only 71% of those eligible to obtain shoes bought them. Podiatrists certified half of those eligible, with internists and orthopedists the next most frequent to certify. Many of those eligible for therapeutic shoes resist wearing these type of shoes. More education to the public and primary healthcare providers is needed to improve the footwear of patients with diabetes to reduce the overall risk of ulceration and amputation.

NEUROPATHIC FOOT ULCERS

Wound healing

To effectively manage a patient with neuropathic foot ulcers, a review of the normal wound healing process and how this normal process is affected by diabetes is needed. The normal wound-healing process involves a coordinated interaction between cellular activities, growth factor activation, and connective tissue formation that takes place over 4 phases of healing. The first phase, the coagulation phase, takes place within minutes to hours of the injury. During this phase, platelets are the primary cells that come to the area. These cells form a fibrin plug (clot) causing hemostasis. The platelets release growth factors and cytokines causing a recruitment of inflammatory cells, thus leading to the second phase of healing, the inflammation phase. Macrophages are the primary cells in the inflammation phase and lead to chemotaxis, cell mitosis, and debridement affording the body’s own cleaning response to the wound. This phase typically lasts 0 to 10 days. The migration phase of healing occurs next, allowing granulation of the wound bed, contraction of the wound area, and promotion of reepithelialization. During the migration phase, angiogenesis begins, and matrix proteins are released. The migration and proliferation of fibroblasts promotes granulation tissue formation. Myofibroblasts promote contraction of the newly formed tissue, and the keratinocyte migration promotes the reepithelialization. The final phase of healing is the maturation phase and can take up to 2 years for completion. This phases allows matrix proteins to be remodeled, production of collagen (type III and type I), and enables the wound to return close to prewound strength. Diabetes has a profound impact on wound healing, resulting in faulty closure and affecting all 4 phases of the healing process. During the past few decades, there has been a greater focus on the effects of diabetes on wound healing, but a complete understanding of these effects is still eluding the scientific community. A pathophysiologic relationship has been discovered between diabetes and wound healing that is complex and multifaceted. This includes micro- and macrovascular impairments, neuropathic issues, immune function alterations, biochemical changes, and hormonal abnormalities, which all contribute to altered tissue repair in patients with diabetes. In the coagulation phase of healing, there is delayed fibrin plug formation and a delay in the release of growth factors and cytokines, leading to a poor immediate
recruitment of inflammatory cells and delaying the inflammation process. This delay in the fibrin plug also allows the wound to remain open to the environment longer, increasing the risk for infection. The inflammatory phase of healing is affected by decreased function of the neutrophils and macrophages. The increased production of the tissue destructive matrix metalloproteinases breaks down not only the debris ahead of the fibrin but also the tissue and cells the fibrin needs for production, resulting in a poor debridement response. Add to this the increased viscosity of the blood, so the cells are slowed in moving to the wound area. These processes delay the start of the inflammatory process and also prolong the inflammation phase that is typically seen in normal wound healing. The proliferative phase of healing is affected by diabetes through reduced response to growth factors. There is decreased angiogenesis, decreased fibroblast migration and proliferation, an excessive protein deposition but with poor remodeling, and a decreased granulation tissue formation. This is presented as slowed granulation of the wound bed, with little to no contracting of the wound size and slowed reepithelialization. The remodeling phase of healing has an ineffective matrix remodeling, decreased collagen production and deposition, decreased angiogenesis, and a decreased wound tensile strength of less than 60% to 80% of the original prewound tissue strength, even after 2 years. This leads to a greater risk of reinjury.

Neuropathic foot ulcers occur most often as a result of decreased sensation on the weight-bearing structures, mainly on the ball of the foot or bottom of the big toe. Ulcers in other locations are usually the result of poor fitting shoes or trauma (ie, stepping on a nail). The common characteristics of a neuropathic ulcer are as follows (Fig 4):

- Plantar aspect of the foot
- Painless
- Round punched out lesion
- Callus rim
- Granular bed

These ulcers are usually the result of poor foot hygiene, decreased sensation, decreased vision for early recognition, poor circulation from hardened arteries, altered biomechanics and weight-bearing distribution, and fluctuating blood glucose levels. There are 2 scales commonly used to classify a neuropathic ulcer (Table 3). The

**Table 3.** Neuropathic ulcer scales for classification

<table>
<thead>
<tr>
<th>University of Texas Diabetic Wound Classification system (grades 0–III)(^a)</th>
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</thead>
<tbody>
<tr>
<td>0—Preulcerative or postulcerative lesion, completely epithelialized</td>
</tr>
<tr>
<td>I—Superficial wound, not involving tendon, capsule or bone</td>
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<tr>
<td>II—Wound penetrating to tendon or capsule</td>
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<tr>
<td>III—Wound penetrating to bone or joint</td>
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<table>
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<tr>
<th>The Wagner Scale (0–5)(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0—Preulcerative lesion, healed ulcers, presence of bony deformity</td>
</tr>
<tr>
<td>1—Superficial ulcer without subcutaneous tissue involvement</td>
</tr>
<tr>
<td>2—Penetration through the subcutaneous tissue, may expose bone, tendon, ligament of the joint capsule</td>
</tr>
<tr>
<td>3—Osteitis, abscess, or osteomyelitis</td>
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<tr>
<td>4—Gangrene of digit</td>
</tr>
<tr>
<td>5—Gangrene of the root requiring disarticulation</td>
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</table>

\(^a\)Note also if infection and/or ischemia is present. From American Diabetes Association.\(^31\)

\(^b\)From Wagner.\(^32\)
University of Texas – San Antonio Classification lacks the consideration of biomechanics and neuropathy but does address infection and ischemia. The Wagner scale is the most widely used scale, especially by podiatrists, and has recently been found to be reliable for patients with ulcers as a result of neuropathy but has less reliability with other patient populations. The Wagner scale also lacks indicators for biomechanics and neuropathy as well as circulation and infection indicators. Both scales do demonstrate the depth of structures involved and can effectively be used to guide treatment and prognosis.

Wound management

Standard of care guidelines as addressed by the American Diabetes Association include a multifactorial approach to wound management. The most important issue is to make sure the patient is controlling his or her blood glucose levels. At every session, blood glucose should be determined. Also, addressing nutrition and hydration is necessary for optimal healing. Current moist wound-healing practices include making sure the wound bed is properly prepared through the following:

- Cleansing of the wound bed at each dressing change
- Frequent and appropriate debridement of callus, fibrin, slough, and eschar
- Controlling infection or decreasing the bioburden of the wound
- Maintaining a proper moisture balance by choosing appropriate dressings to avoid maceration but maintaining a moist wound bed
- Wound edges should be opened to enable cell migration across the wound bed
- Off loading of the wound to reduce pressure through the use of proper shoes or orthotics

Mechanical interventions can also be used to increase circulation and promote the healing process and include negative pressure therapy (commonly seen as vacuum-assisted closure; Fig 5) and physical therapy interventions of pulsatile lavage, low-frequency ultrasound, and mist ultrasound. Total contact casting has been used with patients having neuropathic ulcers, with a 90% healing rate for those who still have good circulation to the area. Hyperbaric oxygen has been used...
to promote oxygenation to the cellular level. Skin substitutes and growth factors, such as Regranex, has been used to promote the migratory phase of healing. Determining the phase of healing that is slowed is the first step to providing the appropriate mechanical intervention.

Determining the proper dressing for the wound can assist in all phases of healing and promote closure. With the variety of brands and types of dressings available on the market today, an understanding of the basic categories of dressings is important. Table 4 shows the basic categories to consider when working with patients with neuropathic ulcers.

Controlling blood glucose levels is a very important component of wound management. High glucose levels reduce the protein synthesis and neutrophil function, leading to prolonged inflammation and decreased granulation and reepithelialization. Infection causes blood glucose levels to increase. Testing hemoglobin A1c will show a weighted average of glucose levels for the last 3 months. This may enable a determination to be made if high glucose level caused the infection, which would indicate a decline in the overall management of diabetes, or if the infection caused high glucose levels. Optimal levels of blood glucose for wound healing are less than 180 mg/dL.

Common testing procedures for determining existence of osteomyelitis include radiographs, bone scans, and white blood cell scans. A common perception is that performing a magnetic resonance imaging on a patient with suspected osteomyelitis is a high-tech, high-cost modality. However, a study by Morrison et al in 1995 demonstrated the usefulness of the magnetic resonance imaging in determining the extent of osteomyelitis that successfully led to foot-sparing limited resection procedures without recurrent infections.

Laboratory values of nutrition (albumin), urine analysis (for hydration and content), and glucose levels over the last 3 months (hemoglobin A1c) are an important component to neuropathic ulcer management. All of these values can give an indication of how well the diabetes is being controlled and can identify impediments to wound healing. Pharmacology interventions, including what the patient is utilizing for diabetes management as well as for any comorbidities, can impede various phases of healing. For example, diuretics can increase blood glucose levels. A social worker can provide insight into the ability of patients and/or their caregiver to follow a plan of care, both physically and mentally. Referral to proper services may be needed to provide the care for optimal wound healing and prevention of further breakdowns. Working with the healthcare team can enable an overall improvement in the outcomes of patients with neuropathic ulcers.

PATIENT EDUCATION

Patient education is an important component of preventive care. Daily foot checks are the first step to find the injury problems early and to obtain appropriate care. Feet should be looked at every day after a bath or shower and before putting on shoes and socks. A hand mirror or a mirror laid flat on the floor is the best way for a patient to look at all areas of the foot. Foot checks should be performed in good lighting and with their eyeglasses on (if needed). Although most people with diabetes know they have to check their feet daily, many do not know how to properly perform this or what they have to evaluate. There are 2 steps to foot checks: look and feel. Feel the feet for any temperature changes. Feet should feel warm all over, with no hot spots. Using the back of the hand or fingers to check this allows detection of smaller changes in temperature. The feet should also be manually scanned for any swelling or tender areas. Next, look at the feet from various directions: at the top, bottom, sides, and between toes, using the mirror to assist. Any color changes such as blue, bright red, or white spots should be noted, as well as any breaks in the skin such as blisters, cuts, sores, or cracks. If any abnormalities are noticed during foot checks,
### Table 4. Wound dressingsa

<table>
<thead>
<tr>
<th>Dressing</th>
<th>Description</th>
<th>Use</th>
<th>Action</th>
<th>Change frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gauze</td>
<td>Dry woven or nonwoven sponges/wraps with varying degrees of absorbency. Fibers include cotton, polyester, or rayon. Can be sterile or nonsterile, with/without adhesive borders.</td>
<td>Cleaning, packing, covering a variety of wounds</td>
<td>Provides little or no occlusion. Moisture vapor freely leaves the wound, resulting in a dry desiccated wound bed. When dry, the gauze adheres to granulating tissue. This can be used for debridement. Wicks exudates from wounds. Can be packed into tunnels.</td>
<td>2–4 times per day</td>
</tr>
<tr>
<td>Transparent film</td>
<td>Polymer membranes of varying thickness and sizes, coated on one side with an adhesive. Impermeable to liquid, water, and bacteria but permeable to moisture vapor and atmospheric gases (semipermeable).</td>
<td>Partial-thickness wounds, with little or no exudates. Wounds with necrosis (promote autolysis). Lacerations/abrasions/second-degree burns. Prophylactic for stage I pressure ulcers to reduce friction. Cover IV sites. <em>Not for infected wounds or moderate or heavy wounds.</em></td>
<td>Promotes autolytic debridement. Allows visualization of the wound. Can be used as a primary or secondary dressing.</td>
<td>Once every 3–7 d</td>
</tr>
<tr>
<td>Foams</td>
<td>Foamed polymers with small open cells. May be impregnated. Area in contact with the wound is nonadhesive. Available with/without adhesive borders. Many varieties.</td>
<td>Partial- or full-thickness wounds: Heavily exuding wounds. Can be used as compression under stockings in chronic venous ulcers or as a cushion over bony prominences.</td>
<td>Absorption capability depends on thickness and composition.</td>
<td>Once every 1–7 d</td>
</tr>
<tr>
<td>Hydrocolloids</td>
<td>Composed of gelatin, pectin, or carboxymethylcellulose. The top layer is a film covering (occlusive). With/without an adhesive border. Variety of shapes and sizes.</td>
<td>Useful in contouring areas such as heels. Indicated for partial- and full-thickness wounds with or without necrotic tissue. <em>Contraindicated for infective wounds.</em></td>
<td>Promotes granulation, softens necrotic slough. Absorption capability depends on thickness and composition—usually for minimal to moderate exudate wounds.</td>
<td>1–5 d</td>
</tr>
<tr>
<td>Hydrogels</td>
<td>Available in tubes, foil packages, spray, or freeze-dried. Can also be impregnated in gauze. Require secondary dressing.</td>
<td>Partial- and full-thickness wounds. Wounds with necrotic tissue.</td>
<td>Rehydrates a wound to maintain a moist environment and to promote autolysis.</td>
<td>Varies with wound and secondary dressing (continues).</td>
</tr>
<tr>
<td>Dressing</td>
<td>Description</td>
<td>Use</td>
<td>Action</td>
<td>Change frequency</td>
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<tr>
<td>Hydrogel sheets</td>
<td>Consists of up to 95% water and anywhere from 6% to 30% cross-linked polymers</td>
<td>Partial- and full-thickness wounds, Wounds with necrosis, Burns, Can be used in the presence of infection, Radiation tissue damage</td>
<td>Provides cooling ability for pain reduction, Promotes epithelial growth, Softens slough to aid debridement, Absorbs varying amounts of drainage depending on the composition</td>
<td>Varies</td>
</tr>
<tr>
<td>Impregnated dressings:</td>
<td>Gauze or nonwoven sponges, ropes, or strips saturated with a solution, emulsion, oil, or some other compound (ie, saline, zinc, petroleum, and xeroform). Nonadherent and requires a secondary dressing</td>
<td>Wounds that need frequent dressing changes, Infected wounds</td>
<td>Does not disturb the granulating bed</td>
<td>Varies</td>
</tr>
<tr>
<td>Antimicrobial dressing</td>
<td>Dressings impregnated with an antimicrobial agent such as silver, iodine, or other agents</td>
<td>Partial- or full-thickness wounds with a bacterial burden, Surgical incisions</td>
<td>Controls bacterial burden of the wound, Ability to handle exudates depends on the product</td>
<td>Varies</td>
</tr>
<tr>
<td>Alginates</td>
<td>Fiber products derived from seaweed Available as sheets, ribbons, pads, or ropes Requires a secondary dressing</td>
<td>Moderate and heavy exudated wounds, Pressure ulcers, diabetic ulcers, and venous stasis ulcers, Infected wounds</td>
<td>Mild bacterial static effect, Controls exudate, thereby reducing dressing changes</td>
<td>Varies</td>
</tr>
<tr>
<td>Collagена</td>
<td>Usually derived from bovine and porcine sources Available in freeze-dried sheets, particles, pastes, or gels Requires a secondary dressing</td>
<td>Partial- and full-thickness wounds, Pressure ulcers, Venous ulcers, donor sites, Surgical wounds, Vascular ulcers, Neuropathic ulcers, Burns, Abrasions and traumatic wounds</td>
<td>Interacts with wound exudates to form a gel and provides a collagen matrix for cellular migration</td>
<td>Varies</td>
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*From Krasner*\(^35\)
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intervention by the primary care provider for proper referrals is necessary. Ordinary problems can quickly worsen and lead to serious complications.

There are basic guidelines for daily skin care and footwear selection developed by the National Institutes of Health and the American Diabetes Association that will help prevent injuries from occurring. The following is a summary of those recommendations. Prevention is the key.

The feet should be kept clean, dry, and soft.

Washing the feet in warm (not hot) water with mild soap and a soft washcloth and drying them gently, even between toes, with a fluffy towel is important. Feet should not be soaked for more than 3 to 4 minutes at any one time. Lotion can be used on the tops or bottoms of feet and not between toes. Powder between toes will help keep the skin dry and lean. Anytime patients are caught in the rain or snow or any other time and their feet get wet, a thorough cleaning should be performed as soon as possible, followed by a foot check as described previously. Swimming can be good exercise for patients with diabetes, but if they swim regularly, petroleum jelly on the feet and toes before getting in the water will help to protect the skin from damage from the water. After leaving the swimming pool, a thoroughly clearing of the petroleum jelly and a foot check should be performed.

Skin care. A patient with diabetes should be instructed to never go barefoot, either indoors or outdoors. When swimming or on the beach, beach shoes should be worn and not shoes with straps between toes (flip flops or beach thongs are not acceptable). Wearing warm, padded cotton socks in the winter will protect the skin from the cold and wet weather. Any socks or stockings should not have holes or holes that have been darned, have thick seams, or have elastic bands that cause visible depressions in the skin. Socks should not be so large that they bunch up in the shoe. Socks should also be changed at least once during the day to prevent the moisture from perspiration irritating the skin. Tape or adhesive products such as corn plasters should not be applied to the feet. These may cause fragile skin to peel away. Hot packs or cold packs should be used on the feet only under close supervision of a healthcare provider.

Nail care. Toenails should be cut straight across to avoid hangnails. Patients who have difficulty seeing their feet, reaching their toes, or have thickened toenails must have a healthcare provider cut the toenails. Thickened nails should also be tested for fungal infection. Corners of nails that are pointed should be filed with an emery board. Removal or shaving of calluses should be performed only by a healthcare professional. Regular removal of calluses reduces pressure under the bony prominences and can help off-load an area to reduce chances of ulcer formation.

Shoewear. Patients should be instructed to shop for shoes in the afternoon when feet are swollen. Feet should be measured every time new shoes are bought because of the changing structures. Both shoes, left and right, should be tried on before buying. If the feet are different sizes, always buy for the larger foot. Narrow toes, high heels, hard soles, and thongs between toes should be avoided. Shoes should be comfortable when bought and not have to be “broken in.” Shoes should fit into the shape of the foot and be made of soft material with a stiff heel counter, padding and flexibility at the ball of the foot, a deep and wide toe box, and a good arch support. Shoes should be checked daily for torn linings, foreign objects, and rough areas. Shake shoes out every time before putting them. Change shoes several times a day to vary the pressure(s) on the foot. Lacing a shoe too tight or too loose can cause mechanical irritation. One finger should be able to be inserted...
snugly between the shoe and the heel of the foot. Shoes should be air dried at night to prevent the moisture buildup, which can lead to further skin irritation.

SUMMARY

Neuropathic foot ulcers are high risk, preceding lower extremity amputation. Wound healing in people with diabetes varies from the normal healing process, often resulting in a chronic, nonhealing wound. Comprehensive assessment and physical examination of the patient and wound are critical in creating an environment where wound healing can occur. Blood glucose level control is a primary component of overall wound management and prevention. Daily foot checks by the patient and the caregiver can supplement annual (or more frequent, if indicated by the Lower Extremity Amputation Prevention score) foot examinations by a healthcare provider to improve early recognition and intervention in preventing further complications. The goal is to improve the frequency of foot evaluations in order to provide a reduction in long-term complications from diabetes. A multifaceted approach can result in improved ulcer prevention and reducing the rate of lower extremity amputation.

REFERENCES

FOOT CARE FOR PATIENTS WITH DIABETES


