CE

1.5 ANCC Contact Hours

The Diabetic Foot Assessment

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The diabetic foot assessment is a key component in the care of a patient with diabetes. The assessment includes risk factor identification in both the diabetic patient's history and physical examination, foot care education, treatment, and referrals as needed. The foot complications related to diabetes such as peripheral neuropathy, foot ulceration, and amputation can be life altering. The American Diabetes Association recommends a diabetic foot examination annually for patients with diabetes with foot care education. Diabetic foot assessment may be recommended more frequently for individuals with risk factors contributing to ulceration, peripheral arterial disease, and peripheral neuropathy. This article reviews the diabetic foot assessment that nurses in healthcare settings and other healthcare professionals should use when caring for a diabetic patient.

Diabetes is a prevalent diagnosis in Americans and worldwide with serious health complications. The American Diabetes Association (ADA) reported that in 2012, 29.1 million Americans, or 9.3% of the population, had diabetes (American Diabetes Association, n.d.). Worldwide, diabetes affects 382 million people and is one of the leading causes of chronic disease and limb loss (Hingorani et al., 2016). In the United States, it was reported in 2010 that diabetes was the seventh leading cause of death (ADA, n.d.). Diabetes affects several organ systems including the feet and lower legs with life-changing complications that can be monitored and may be preventable with a full lower extremity history, physical, and treatment plan with patient education. This article will provide an awareness for nurses in the orthopaedic setting, nurses in other settings, both inpatient and outpatient, and other healthcare professionals regarding the importance of conducting a diabetic foot assessment to determine risk factors that may lead to limb loss and premature death.

Complications related to the diabetic foot include diabetic peripheral neuropathy, skin changes, calluses secondary to high pressure areas on the foot, foot ulcerations, and peripheral arterial disease (PAD). Diabetic foot ulcerations are a severe complication with life-altering implications. There is an estimated lifetime risk of a diabetic patient developing a foot ulceration of approximately 25% (Bowling, Rashid, & Boulton, 2015). Once a foot ulceration occurs, the risk of amputation is increased. Approximately 80% of diabetes-related lower extremity amputations are preceded by a foot ulceration (Hingorani et al., 2016). After an initial amputation, the risk of contralateral extremity amputation ranges between 9% and 17% in the first year and then increases to 25%–68% within 3–5 years (Alavi et al., 2014) Multiple studies have reported that the 5-year survival rate after lower extremity amputation is 41%–70 % (Alavi et al., 2014). Diabetic foot ulceration risk factors included neuropathy, PAD, foot deformity, limited ankle range of motion (ROM), high plantar pressures, minor trauma, previous ulceration or amputation, and visual impairment (Higorani et al., 2016). Several of these risk factors are evaluated during a complete lower extremity examination. The podiatric physician specializes in the lower extremity, specifically the ankle and the foot. A thorough diabetic foot examination performed by a podiatrist addresses the aforementioned complications and risk factors. A podiatrist has specialized education of the lower limb with foot and ankle residency training involving a large number of the patients with diabetes who are treated both conservatively and surgically. A rapid diabetic foot examination by a healthcare professional may lead to referral to a podiatrist for further evaluation and treatment.

Diabetic Foot Examination Recommendations

The American Diabetes Association Guidelines (2016) has recommendations that all individuals with diabetes need to have at minimum an annual diabetic foot examination to identify risk factors for ulcers and amputations. This should begin upon the diagnosis of Type 2 diabetes and 5 years after the diagnosis of Type 1 diabetes (Diabetes Care by ADA, 2016). Frequency of the diabetic foot examination may increase from more than once a year when risk factors, such as peripheral

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neuropathy, are identified. Diabetic peripheral neuropathy is simply defined as the presence of symptoms and/or signs of peripheral nerve dysfunction in people with diabetes and will be explained in further detail in the section about conducting a neurologic examination. Both Type 1 and Type 2 individuals with diabetes should have a comprehensive foot examination. Type 2 diabetes comprises approximately 90%–95% of diabetes cases. In 2015, an estimated 1.5 million new cases of diabetes were diagnosed in Americans 18 years of age and older (Centers for Disease Control and Prevention [CDC], n.d.).

The proportion of individuals with diabetes, 65 years of age and older, remains high at 25.9% or approximately 11.8 million (ADA, n.d.). It is estimated that 18% of patients with diabetes have received a foot check (Peterson & Virden, 2013). Other studies reported that 23%–49% of patients with diabetes had their feet evaluated annually by their primary care physicians (Scott, 2013). The need for a quality diabetic lower extremity examination is critical to the care of the patient with diabetes. Although the statistics regarding foot ulceration and amputation are alarming, the rate of amputations can be reduced by 45%–85% with a comprehensive foot care program that includes risk assessment, foot care education and preventative therapy, treatment of foot pathology, and referral to specialists (Scott, 2013).

Healthcare professionals that include podiatrists, nurses, primary care physicians, endocrinologists, and physician assistants have the ability to recognize changes and abnormalities in the diabetic foot when conducting a diabetic foot examination. The examination encompasses a thorough history and a concise physical assessment addressing the neurologic, vascular, dermatologic, and musculoskeletal aspects of the lower extremity. Abnormal findings and risk factors may be obvious or subtle. The time spent during the diabetic foot assessment provides the opportunity to assess the patient's knowledge of controlling his or her diabetes, the risk factors in both the history and physical examination, conducting foot care or referral for foot care as needed, and foot care education.

Components of the Diabetic Foot and Lower Extremity Assessment

The diabetic lower extremity assessment entails several pertinent areas including, a focused diabetic history and systemic risk factor evaluation. A physical examination involves the evaluation of the neurologic, vascular, dermatologic, and musculoskeletal systems pertaining to the lower extremity. Diabetic education should address how diabetes can affect the feet, the related risk factors, referral for risk factor modifications, and diabetic foot education to the patient and the family including how to conduct foot care at home.

Patient History

The patient history should begin with reviewing the patient's pertinent medical comorbidities, diabetic history, blood glucose control, and previous diabetic complications (Giovinco & Miller, 2015; Miller et al., 2014). It is important to obtain the most recent A_{1C} level because it will provide the clinician with an overall assessment of a patient's glycemic control (Giovinco & Miller, 2015). The American Diabetes Association recommends an A_{1C} less than 7% for nonpregnant adults with diabetes (Diabetes Care, 2016). An A_{1C} maintained at approximately 7 % can reduce risk of microvascular complications (Giovinco & Miller, 2015). Tight glycemic control is the only strategy convincingly shown to prevent or delay the development of diabetic peripheral neuropathy (Diabetes Care, 2016). Comorbidities and complications that may need to be addressed in the health history may include a history of hypertension, hyperlipidemia, peripheral vascular disease, visual impairment, diabetic nephropathy including dialysis, previous lower limb wounds or interventions, and diabetic peripheral neuropathy (Boulton et al., 2008; Giovinco & Miller, 2015; Miller et al., 2014). Smoking and nicotine use should be reviewed in the patient's history because these are risk factors that contribute to PAD and coronary artery disease (Miller et al., 2014). Finally, subjective symptoms that indicate risk factors of peripheral neuropathy should be addressed in the history and the physical examination. These symptoms may include subjective paresthesias such as burning, tingling, shooting pain in the feet or legs, or numbness that would indicate concerns for peripheral neuropathy or symptoms of intermittent claudication or rest pain to indicate concerns for PAD. However, up to 50% of patients with diabetic peripheral neuropathy may be asymptomatic and yet are still at risk for injury to their feet (Diabetes Care, 2016).

Once a thorough history is reviewed with the patient, the lower extremity physical examination is performed and includes assessment of the lower extremity and assessment of these systems: neurologic, vascular, dermatologic, and musculoskeletal. Each system is addressed later as it pertains to the assessment of the lower extremity and identification of risk factors for the diabetic foot. The examination may begin with any of these body systems; however, for the purpose of this article, the neurologic examination is addressed first.

Neurologic Examination

Diabetic peripheral neuropathy is a devastating complication of diabetes and one of the main risk factors for foot ulceration and potential amputation. The affects can be life changing. Diabetic peripheral neuropathy is a symmetrical polyneuropathy characterized by both sensory and motor components (Juster-Switlyk & Smith, 2016). It is a result of metabolic and small vessel changes that can be attributed to chronic hyperglycemia. Motor involvement is not typically seen until later stages of diabetic peripheral neuropathy. Symptoms may vary depending on the class of sensory fibers that are involved, whether small or large fibers (Diabetes Care, 2016). Small fiber involvement usually includes paresthesias and pain that may be seen as an earlier symptom. Large fiber involvement may lead to numbness and loss of protective sensation (LOPS; Diabetes Care, 2016). Sensory symptoms begin distally in the

toes and can eventually affect the fingers and upper limbs in a distribution classically described as a "stocking and glove" pattern. Sensory symptoms, or paresthesias, may include loss of pain sensation or insensitivity, tingling, "pins and needles" sensation, burning, "electrical shocks," allodynia (painful sensation to an inoffensive stimuli), or hyperalgesia (increased sensitivity to painful stimuli). Interestingly, symptoms are not a predictable indicator of the severity of nerve damage (Juster-Switlyk & Smith, 2016). Frequently, patients with the most severe, painful symptoms have minimal or no LOPS on examination.

In the presence of neuropathy, ulceration occurs as a result of unperceived trauma to the foot (Boulton, 2015). The combination of insensitivity and extrinsic factors such as walking barefoot and stepping on a sharp object, or simply wearing ill-fitted shoes can contribute to ulceration (Sinwar, 2015). Excessive pressure and friction from inappropriate shoes can promote blistering and callus formation, which may evolve into breakdown of the skin, infection, ulceration, and possible amputation (Scott, 2013).

The purpose of the lower extremity neurologic examination is to establish whether a patient is at increased risk of developing an ulceration as a result of LOPS; Scott, 2013). All patients should be assessed for diabetic peripheral neuropathy upon being diagnosed with Type 2 diabetes and 5 years after being diagnosed with Type I diabetes and should be assessed annually thereafter (Diabetes Care, 2016). Assessment for neuropathy should always include 10-g monofilament testing and at least one other clinical test for neurologic evaluation (Diabetes Care, 2016). Additional clinical tests that may be performed to identify the LOPS include vibration with a 128-Hz tuning fork or vibration perception threshold (VPT), pinprick sensation, and ankle reflexes (Scott, 2013).

Clinical Neurologic Tests (Performed Bilaterally)

The neurologic assessment begins with the evaluation of protective sensation using a 10-g monofilament. An alternative for practitioners that do not have a monofilament is the Ipswich touch test. Then one additional neurologic test will be performed in addition to the 10-g monofilament, as recommended by the American Diabetes Association. Absence of monofilament sensation suggests LOPS, whereas at least two normal tests and no abnormal tests rule out LOPS (Diabetes Care, 2016). The clinical neurologic tests are described in detail later.

Monofilament Examination (10 g)

Monofilaments, known as Semmes-Weinstein monofilaments, were originally used to diagnose sensory loss in leprosy (Boulton et al., 2008). A monofilament is a handheld tool that is composed of a thin nylon wire to touch the patient's skin and a handle for the provider to hold. Weinstein found that a nylon filament 0.005 wide and 38-mm long provided a mean force that is a good predictor of "normal" light touch-deep pressure threshold for most of the body (Bell-Krotoski, Ewing Fess, Figarola, & Hiltz, 1995). There is strong evidence confirming that LOPS detected by the monofilament test is an effective tool in predicting foot ulceration (Scott, 2013).

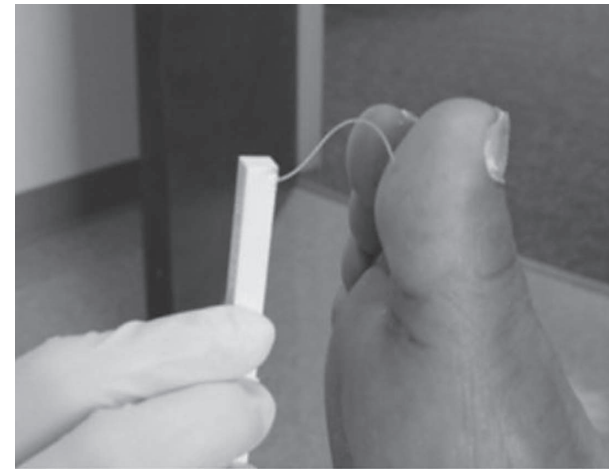

Figure 1. Semmes Weinstein Monofilament Buckling during examination.

The monofilament is constructed to buckle or bend when 10 g of force is applied to the plantar surface of the foot, as seen in Figure 1 (Boulton et al., 2008). The monofilament may be tested over a total of 10 sites, as seen in Figure 2, but several articles suggest that four sites are recommended for testing of LOPS (Boulton et al., 2008; Giovinco & Miller, 2015). These sites include the plantar first, third, and fifth metatarsal heads and at the plantar surface of the distal hallux. The clinician should first demonstrate the sensation of the buckling monofilament by applying it to a proximal site that likely has intact sensation, such as the patient's arm, so that the patient can become familiar with the stimulus that the monofilament provides (Boulton et al., 2008). Next, examine the foot by first asking the patient to close his or her eyes and to indicate "yes" or "no" when asked whether the monofilament is being applied at a particular site trying to avoid areas of callus to ensure accurate perception of pressure (Giovinco & Miller, 2015).

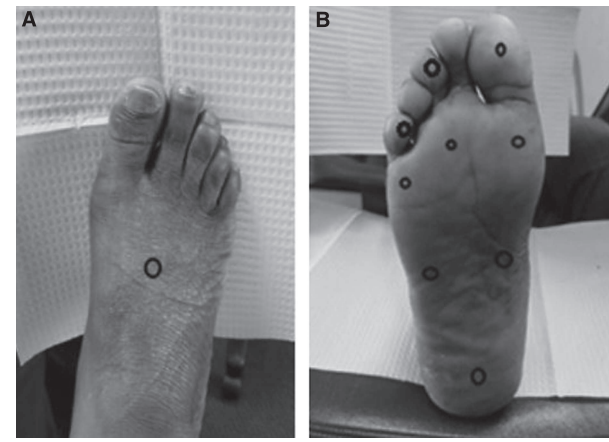

Figure 2. Semmes Weinstein Monofilament test sites. A, Dorsum of foot sites. B, Plantar foot sites.

Figure 3. Ipswich touch test.

Ipswich Touch Test

This test is an alternative to the monofilament test that can be performed in the absence of instruments and requires no special training (Giovinco & Miller, 2015). The test has similar sensitivity, specificity, and operating characteristics as the monofilament test. The examiner should lightly rest the tip of his or her index finger for 1–2 s on four separate anatomic sites, as seen in Figure 3. These sites include the dorsal aspect of the hallux and the tips of the patient's first, third, and fifth toes (Giovinco & Miller, 2015). Avoid pushing, prodding, or poking the skin, as this would elicit sensation other than light touch.

Additional Clinical Tests

After assessing the protective sensation with either monofilament or Ipswich touch test, one additional clinical test should be performed. This additional test may include any of the following clinical tests: vibratory sensation evaluation with either a 128-Hz tuning fork or by biothesiometer that can quantify VPT, pinprick sensation, or an ankle reflex (Achilles reflex).

128-Hz Tuning Fork

A podiatrist will commonly test vibratory sensation with a 128-Hz tuning fork. Tuning forks are widely available and are a simple way to assess for vibratory sensation. To test, activate the tuning fork and apply it to the distal tip of the great toe. An abnormal response is interpreted if the patient stops feeling the vibration prior to the examiner, who continues to perceive the vibration while holding the tuning fork (Boulton et al., 2008).

Vibration Perception Threshold

This test requires a biothesiometer, which is a specialized instrument that can quantify the VPT (Scott, 2013). A biothesiometer is not readily accessible for the majority of practitioners and may be used only in specialty clinics. Vibration perception threshold is one of the earliest indicators of neuropathic LOPS and the best predictor of long-term lower extremity complications (Miller et al., 2014). Because of the expense, length of time to perform an evaluation, and training of proper use, the 128-Hz tuning fork is a regularly used alternative (Miller et al., 2014). The test is conducted with the patient in a supine position. The patient is asked to detect vibration at the great toe via the biothesiometer. Three readings are documented and averaged to obtain the mean value of the detected amplitude. A measurement of 25 V or greater is considered an abnormal result and is strongly predictive of a future foot ulceration.

Pinprick Sensation

This test evaluates the patient's response to sharp stimuli, which is a small fiber function (Diabetes Care, 2016; Giovinco & Miller, 2015). A disposable pin will be touched to the skin of the dorsal great toe just proximal to the nail, using just enough pressure to depress the skin without piercing the skin. (Boulton et al., 2008) An inability to perceive the pinprick would be interpreted as an abnormal result and associated with increased risk of ulceration.

Ankle Reflexes (Achilles Reflex)

Ankle reflexes test large fiber function. Ankle reflexes are to be tested with a reflex hammer while the patient seated on the clinic table or lying prone (Giovinco & Miller, 2015; Scott, 2013). Dorsiflex the patient's foot to a neutral position of 90° to stretch the Achilles tendon. Next, strike the hammer just proximal to the insertion of the Achilles tendon at the posterior calcaneus (Giovinco & Miller, 2015). If the reflex is absent, it is important to repeat the test while the patient performs the Jendrassik maneuver to ensure an accurate result. The Jendrassik maneuver is achieved by interlocking cupped hands in front of the chest and attempting to pull them apart (Giovinco & Miller, 2015). A reduced ankle jerk is likely indicative of peripheral neuropathy. Absence of an intact ankle reflex is an additional risk factor for foot ulceration.

The neurologic examination is key to the diabetic foot assessment. The patient with diabetes with peripheral neuropathy could be up to 50% asymptomatic (Diabetes Care, 2016). These asymptomatic patients are still at risk of developing complications such as ulceration and possible limb loss without the knowledge of their risk factors. A good neurologic foot examination will lead to awareness of the risk factors the patient has and discussion of preventative and monitoring measures for the patient.

Vascular Examination

Diabetes is a major risk factor for PAD and may have prevalence of 10% to 40% among the general population of the patient with diabetes. (Hingorani et al., 2016). Peripheral arterial disease is a risk factor for diabetic foot ulceration and amputation because wound healing is impaired with limited blood flow. Hingorani et al. (2016) reported that the mortality of a patient who has diabetes, PAD, and has had an amputation is 50% at 2 years. Assessment for PAD is essential in risk stratification for lower extremity ulcerations. The vascular examination should begin with conducting a history of

PAD symptoms of intermittent claudication and rest pain. Intermittent claudication is pain in the legs or calves when walking a reproducible distance that requires the patient to stop for symptom relief. Rest pain is pain in the feet, legs, or calves with elevation of the legs, such as in bed at night or in a recliner. The patient requires dependency of the legs, such as dropping the legs over the side of the bed, to relieve the symptoms. After a symptom history is taken, assessment of the pedal pulses at the dorsalis pedis artery and posterior tibial artery by palpation is performed. Pedal pulse palpation should be on the barefeet of the patient. The dorsalis pedis should be palpated using two to three fingers across the dorsum of the foot approximately 1 cm proximal to the depression between the first and second metatarsals (Scott, 2013). The posterior tibial artery should be palpated along the medial surface of the ankle posterior to the medial malleolus. These locations will also be the location for the placement of the probe in Doppler ultrasonography if needed. The pulses may be rated as bounding, palpable, barely palpable, or absent and may be designated a numerical value.

If the pedal pulses are palpable, the examination may continue with the evaluation of the presence or absence of hair growth on the feet and the legs, skin quality (does the skin appears thin, shiny, and atrophied), skin temperature, and skin color such as dependent rubor may be noted (Sinwar, 2015). Dependent rubor may be noted while the patient's legs are in a dependent position and appear red and ruddy in color, but upon elevation at 45° or more, the leg will pale or have pallor. Skin temperature should be evaluated with the back of the examiner's hand from the tibial tuberosity distally toward the toes with the temperature gradually decreasing distally (Boxer, 2006). In PAD, a drop in skin temperature may occur rapidly with the skin being cool to cold in some patients. Focal or global skin temperature difference between contralateral limbs is a sign of vascular compromise (Boulton et al., 2008).

In the absence of palpable pedal pulses, further assessment is required. A Doppler ultrasound device can be used to listen for an audible pulse waveform. The audible pulse waveform can then be interpreted. An artery should sound pulsatile with two or three sounds described as biphasic or triphasic, which sounds similar to auscultation of the heart. In PAD, the artery may be audible but not pulsatile and is described as monophasic (a single sound). The pulse may also be inaudible or monophasic, which indicates poor circulation requiring the need for further assessment. An Ankle Brachial Index (ABI) is a valuable assessment tool that can be performed in many settings both outpatient and inpatient. An ABI is indicated for absent pulses, monophasic audible pulses, and symptomatic pain noted in the vascular history during a diabetic foot assessment. The clinical practice guidelines for the management of the diabetic foot by the Society of Vascular Surgery in collaboration with the American Podiatric Medical Association and the Society for Vascular Medicine recommend an annual examination of the lower extremity and foot including an ABI and toe pressures for individuals with diabetes at 50 years of age, with prior diabetic foot ulcer, abnormal vascular examination, prior intervention for peripheral vascular disease, or known atherosclerotic cardiovascular disease (Hingorani et al., 2016).

An ABI is performed with a blood pressure cuff and Doppler ultrasound. The brachial systolic pressure is taken and the pressure at the dorsalis pedis or posterior tibial pulses taken. These pressures are then used to calculate the ABI by dividing the ankle pressure by using the higher of the brachial pressures in either the right or left arm (Boulton et al., 2008). The American College of Cardiology Fellows ABI guidelines state that a calculation of 1.0–1.4 is normal, 0.99–0.9 is borderline, less than 0.9 is abnormal, and above 1.4 may indicate calcification of vessels (American Heart Association, 2017). A value of 1.4 and above or 0.9 and less should be further evaluated with other noninvasive vascular testing. Peripheral arterial disease in the diabetic patient is often more severe and associated with poorer outcomes than in the nondiabetic population (Boulton, 2015). The vascular examination is essential to a diabetic foot examination to assess for the risk of PAD and need for a referral to a vascular medicine physician or vascular surgeon for further assessment, diagnosis, and intervention.

Dermatologic Examination

The skin of a person with diabetes is another essential system that needs to be evaluated during the diabetic foot assessment. The skin is a key barrier and first line of defense against infection. When the integrity of the skin is compromised, it becomes vulnerable to the introduction of pathogens from the external environment and may serve as a portal for infection. During the physical examination of the pedal skin, note any changes in color, dryness, cracking, minor lesions, or ulceration (Giovinco & Miller, 2015). The patient with diabetes who has a breakdown in his or her skin may be more susceptible to limb-threatening complications such as an ulceration of the foot. Ulcerations or wounds that have two or more of the following signs may be considered infected: edema, malodor (foul smell), erythema, tenderness, or purulent drainage (Sinwar, 2015).

Examination of the skin should begin with the proximal aspect of the lower leg to the distal aspect of the toes. A meticulous dermatologic inspection requires examining between the toes for skin breakdown, calluses, fungal infection, or ulceration (Giovinco & Miller, 2015; Scott, 2013). Patients with diabetic neuropathy usually suffer from peripheral autonomic dysfunction, which leads to dry skin that is prone to cracking and fissuring (Boulton, 2015). A patient with diabetes may have certain dermatologic markers, such as shin spots or diabetic dermopathy (presence of multiple hyperpigmented atrophic macules on the legs), necrobiosis lipoidica diabeticorum (asymptomatic shiny irregular, hyperpigmented plaques on the shin; varying in color from light yellowish to reddish–tan), bullosum diabeticorum (asymptomatic fluid-filled bullae found on the upper and lower extremities), and granuloma annulare (benign, asymptomatic, self- limiting eruption with color ranging from flesh color to erythematous; Shirazi, Nasiri, & Yazdanpanah, 2016).

Scaly skin may indicate a lack of hydration, anhydrosis secondary to diabetes, or a tinea pedis (athlete's foot

infection; Shirazi et al., 2016). Skin turgor is assessed for hydration and is the skin's degree of resistance to deformation and is used to assess the degree of fluid loss (Shirazi et al., 2016). Skin turgor is measured by tenting the skin between two fingers and then releasing the skin. If skin has normal turgor, it will return to normal rapidly; however, skin with reduced turgor will remain elevated.

The toenails are assessed for the presence of thickness, fungal infection, length, and ingrowing nail borders. If nail polish is present and obscuring assessment of the nails, it should be removed. The feet should be evaluated for hyperkeratotic tissue (commonly called calluses or corns) especially in weight-bearing surfaces such as the plantar metatarsal heads, other areas of bony deformity, or excessive pressure areas from weight bearing or footwear. Hyperkeratotic areas that have intradermal hemorrhage are considered preulcerative and should be offloaded and monitored closely. Refer to Figure 4 for an example of a hyperkeratosis with intradermal hemorrhage (preulcerative). If there is a waxy appearance beneath a callus, it may indicate fluid and the area should be palpated for fluctuance (wavelike movement; Neville, Kayssi, Buescher, & Stempel, 2016).

The dermatologic examination aids the podiatrist or other healthcare professional to evaluate and treat these concerns or refer the patient to a foot specialist. A thorough dermatologic examination serves as a barometer for early intervention and often results in a limb-saving referral to a specialist (Miller et al., 2014). The presence of a callus in an insensitive foot is highly predictive of subsequent foot ulceration (Boulton, 2015). The patient with diabetes with an insensate foot who cannot assess the foot for various reasons, such as decreased eyesight, will benefit from the help of a healthcare professional.

Figure 4. Hyperkeratosis (callus) with intradermal hemorrhage.

Musculoskeletal Examination

The musculoskeletal examination includes assessment of bony deformities, biomechanical faults or ROM, and muscle strength. The examination also includes evaluation of the individual's shoes. If there are foot deformities, neuropathy, and dysfunction in the lower extremity, these are risk factors that increase plantar pressures and may increase the risk of developing foot ulcers in patients with diabetes (Tang et al., 2015). First, the foot should be inspected for bony deformities. Among the more common deformities are contracted digits such as claw toes and hammertoes, bunions (hallux valgus), Tailor's bunion (prominence of fifth metatarsal head), prominent metatarsal heads, and Charcot arthropathy (Tang et al., 2015). These areas can potentially create problems with how well the shoe fits and an increase plantar pressure that may alter a person's gait (Neville et al., 2016). Digital deformities can be rigid (unable to be manipulated into correct position) or flexible (reducible). Although both rigid and flexible contractures can lead to abnormal areas of pressure, rigid deformities conduct retrograde pressure from shoes, which causes prominent metatarsal heads at the bottom of the feet (Scott, 2013). These bony prominences create an altered distribution of pressure during weight bearing that results in formation of calluses and ulceration (Scott, 2013). These foot deformities can be found in many people in the general population; however, in the diabetic patient, the potential for a serious complication should always be considered. If there is repeated trauma to these sites either from direct pressure or from some type of shear force, there is the possibility that an ulcer may develop. Other foot deformities that may be present include flatfoot, cavus (high-arch foot), gastroc equinus (tight Achilles tendon), foot drop, and prior amputations. A weight-bearing examination will aid the podiatrist or other healthcare professional to evaluate arch height. If there is erythema to a bony prominence from increased pressure, callus formation, infection, or breakdown of the skin in any area overlying a musculoskeletal structure, this should be documented and a referral should be made to a podiatrist for further evaluation (Scott, 2013).

During the inspection of the foot, the patient with diabetes with LOPS should be screened for Charcot neuropathy. In the acute stage of Charcot neuropathy, the foot presents as warm, swollen, and sometimes painful (Boulton, 2015). A unilateral warm, edematous foot should be considered Charcot neuroarthropathy until proven otherwise. As the neuropathy progresses, it is characterized by joint dislocations, deformities, and pathologic fractures. Charcot neuropathy commonly results in a rocker-bottom deformity of the midfoot (Giovinco & Miller, 2015), which is associated with increased plantar pressures, predisposing the involved foot to ulceration because this is an area of the foot that is normally not used heavily for weight bearing. Charcot neuroarthropathy may cause a severe collapse of the foot structure that may lead to an amputation (Boulton,

2015). A diagnosis of Charcot neuroarthropathy requires immediate referral to a foot specialist.

The ROM of the foot is assessed in multiple joints by the podiatric physician, but areas that can be quickly assessed by other trained healthcare professionals include the ankle joint dorsiflexion and plantarflexion and the great toe joint (first metatarsophalangeal joint) dorsiflexion and plantarflexion. If there is reduced ROM in these joints, it could lead to callus formation which if not addressed may result in breakdown of the skin and possible ulceration. Muscle strength of the foot in both dorsiflexion and plantarflexion may be assessed by asking the patient to push the foot up and down against your hands. Other muscle groups may be evaluated for strength.

Shoe evaluation should be performed to assess points of irritation or skin breakdown related to the shoes and bony prominences. The research of Tang et al. (2015) highlighted the fact that prevalence of plantar callosities, hypotrophic fat pad, and low forefoot arches are in need of protective footwear to prevent development of diabetic foot ulcers. The inside of the shoes should also be inspected for any foreign bodies. The sole of the shoe should be inspected for excessive wear patterns. If high pressure areas are found, referral to a podiatrist may be appropriate for footwear recommendations, offloading options, and purchasing specialized diabetic shoes with custom inserts made for the individual.

The musculoskeletal examination is essential for identifying factors that can lead to a diabetic foot ulcer. Studies have shown that about 50% of amputations and foot ulcers in patients with diabetes may be prevented with efficient identification of a problem and patient education (Boulton, 2015). A thorough assessment of the diabetic foot and prompt referral to the appropriate specialist could save a limb and reduce healthcare costs.

Patient Education

Patient education is of the utmost importance in the diabetic foot assessment. The podiatrist or other diabetic health provider should not only examine the patient's feet, lower legs, and assess risk factors during the patient history, but also should educate the patient about their examination findings. This will help the patient be aware of their current or future risk factors. After educating the patient on their examination findings, the podiatrist or healthcare provider should continue with education on foot care. Patient education that is consistent and repeated may increase patient adherence to suggested home care behaviors and therefore improve patient outcomes (Giovinco & Miller, 2015; Miller et al., 2014). It is critical that the patient is assessed about their knowledge regarding their diabetic foot care. This will develop a starting point for individualized patient education. The patient with diabetes who does not understand appropriate self-care and the effects of diabetes on their feet and body poses a barrier to prevention of complications (Giovinco & Miller, 2015; Miller et al., 2014). This lack of diabetic foot education and risk factor awareness may be a factor in more than 90% of recurrent ulcers (Giovinco & Miller, 2015; Miller et al., 2014). The American Diabetes Association recommends that diabetics with high risk foot conditions such as LOPS, PAD, foot deformities, and history of ulceration or amputation need to be educated about their risk factors and the management of these risk factors (Diabetes Care, 2016).

Diabetic education includes the following areas: skin care, nail care, foot monitoring, and footwear. The patient with diabetes should keep his or her skin clean and well hydrated. It is important to cleanse his or her feet daily and dry the feet well. It is important that the patient with diabetes does not soak his or her feet because soaking can cause increased drying of the skin and lead to infections, especially if the skin becomes macerated (too wet), which may cause fissures or cracks in the skin serving as entry points for bacteria (CDC, n.d.; Diabetes Care, 2016; Miller et al., 2014). Care should be taken with water temperature because peripheral neuropathy may impede the individual's ability to appropriately assess the warmth of the water. It is recommended that the patient use his or her elbow or a thermometer to test water temperature which should be 90°F–95 °F (CDC, n.d.). This precaution should be used with other hot surfaces the patient may walk on such as hot concrete or asphalt in warm climates. Therefore, the individual should not be barefoot. Caution should be used in extreme cold and thick socks and shoes should be worn (CDC, n.d.). The patient should not use heating elements to warm his or her feet. The patient should be informed not to be barefoot or in stocking feet especially with LOPS.

Because the patient with diabetes may suffer from dry skin as a complication of his or her diabetes, lotion or thick emollient cream may be used to the feet and the legs daily but not between the toes because of excessive moisture in these areas (CDC, n.d.). The individual should be instructed on the importance of daily foot inspection to all parts of the feet and legs including the top, bottom, and webspaces of the feet. Any cracks, fissures, ulcerations, blisters, preulcerative areas, or other skin lesions should be noted. If any of these are found, the podiatrist or healthcare provider should be notified. For individuals with impaired vision, difficulty bending to view the plantar surface of the foot, or other impairments that may impede careful inspection of the foot, this may be done by a family member, significant other, or home health aide. If the patient has good eyesight but cannot move well to see the foot, an assistive device can be used such as a long-handled mirror (Diabetes Care, 2016; Miller et al., 2014).

Shoes should be worn with socks to prevent friction between the shoe and the skin. Socks should be a breathable material such as cotton or wool. Color of socks is a preference of the patient, but white socks will show drainage or blood easily and can be an indicator to the patient that there is a concern with his or her foot. If drainage or blood is observed, the podiatrist or the healthcare provider should be notified. The patient should be advised that footwear should be well fitting and appropriately sized (CDC, n.d.; Diabetes Care, 2016). When buying shoes, it is important to be measured for size and width. Patients may be encouraged to try on and purchase shoes at the end of the day to accommodate for possible foot swelling. All shoes should have a slow break in period, and it is recommended that the person wear the new shoes for 1 hr a day and increase the time daily. During the break in period, the feet should be inspected for blisters, redness, or areas of

shoe irritation. Before putting on his or her shoes, the patient should use his or her hands to inspect the interior of his or her shoes for debris and examine the sole of his or her shoe for excessive wear or holes in the sole and possible debris piercing the sole (CDC, n.d.). The patient with LOPS and/or foot deformities may need specialized footwear with either diabetic shoes that have extra depth and width with specialized inserts or custom-made shoes if no other shoe fits the foot deformity as in Charcot deformities.

Toenails should be trimmed carefully by the patient or a family member following the natural contour of the nail if the patient has low-risk factors or by a podiatrist or other trained healthcare professional if risk factors are present. Calluses or corns should not be treated by the patient with an instrument or over-the-counter medication but should be evaluated by a podiatrist or other trained healthcare provider (CDC, n.d.).

The podiatrist or other healthcare professional should also follow the glycemic control of the patient and help educate on acceptable glycemic control ranges and refer as needed. All of these areas should be addressed during the diabetic foot examination with the patient and reiterated at subsequent visits. Refer to Table 1 for a brief synopsis of important areas for diabetic foot care education.

Two final points that should conclude the diabetic foot assessment are when the individual should come in for his or her next appointment and are there any referrals needed? The American Diabetes Association has a risk stratification for treatment and follow-up of the patient with diabetes, as seen in Table 2 (Giovinco & Miller, 2015). The risk category is from 0 to 3. The risk category 0 is no LOPS, PAD, or deformity and seen a minimum of annually with patient education (Boulton et al., 2008; Giovinco & Miller, 2015). The risk category 1 is LOPS ± deformity and seen every 3–6 months with specialized footwear considered, patient education, and possible surgical intervention for deformity (Boulton et al., 2008; Giovinco & Miller, 2015). The risk category 2 is PAD ± LOPS and seen every 2–3 months with specialized shoes considered and vascular referral or consultation (Boulton et al., 2008; Giovinco & Miller, 2015). The risk category 3 is history of ulcer or amputation and seen every 1–2 months with patient education and a vascular referral if PAD present (Boulton et al., 2008; Giovinco & Miller, 2015). These recommendations aid in the clinician's decision of planned follow-up as well as other factors such as glycemic control and adherence. Referrals are recommended in the presence of PAD, further neuropathy confirmation and treatment, and other diabetic complications to the appropriate treating physician.

Conclusion

The diabetic foot assessment is an essential part of the treatment and management of the patient with diabetes that is recognized within evidence-based practice guidelines by several entities including the American Diabetes Association. The patient with diabetes may have complications that can affect several organ systems that may result in tragic outcomes. Diabetic foot complications can be life altering and limb threatening and may be prevented or slowed with a complete and thorough diabetic foot assessment. All healthcare professionals, including nurses in the orthopaedic setting and other settings who may be a point of first contact for the patient, should conduct a diabetic foot assessment that may lead to a referral to a podiatrist for further risk factor assessment, continued diabetic foot assessment, treatment, and continued foot care education. The examination

Table 1. Diabetic Foot Examination Essentials

Vascular
Palpate dorsalis pedis and posterior tibial pulses.
If pulses absent, Doppler pulses.
Assess for shiny, thin, atrophied skin with no hair growth.
Evaluate skin temperature and skin color.
Neurologic
Assess protective sensation with Semmes Weinstein monofilament, if monofilament unavailable, then Ipswich touch test.
One other clinical test: Vibratory sensation with tuning fork or VPT if biothesiometer available, ankle reflexes, pinprick sensation.
Dermatological
Assess for open lesions, wounds, cracks, or fissures in skin.
Assess skin for dryness or possible fungal infection.
Look between the patient's toes for skin breakdown or maceration.
Assess toenails for color, thickness, length, ingrown nails.
Musculoskeletal
Inspect the foot for foot deformities or boney prominences.
Range of motion to the ankle and first MPJ.
Muscle strength of dorsiflexion and plantarflexion at the ankle.

Note. MPJ = metatarsophalangeal joint; VPT = vibration perception threshold

Table 2. Diabetic Foot Education Essentials

Daily foot inspection with aid if needed.
Skin hydration with lotion or thick emollient except between the toes if skin is dry.
Appropriate fitting shoes for any foot deformities. The patient should break in shoes slowly and evaluate for redness, blisters, or other irritation from shoe gear and discontinue if noted. Continually assess shoe wear.
No barefoot outdoors or indoors.
Assess water temperature prior to bath for warmth.
Suggest thick socks with shoes for cold temperatures.
Dry feet well after bath or shower including between the toes.
Soaking is not generally recommended.
Nails should be cut with the natural contour of the nail and if patient is unable or other risk factors, he or she should be evaluated and debrided by a trained medical professional.
Any drainage noted of socks or feet, ulcerations, blisters, or redness should be reported to the podiatrist or other medical professional who evaluates the patient's feet.
Discuss A_{1C} levels and glycemic control with the patient.

Table 3. ADA Risk Stratification and Recommendations Based on Findings During Comprehensive Foot Examination

Risk Category	Definition	Treatment	Follow-Up
0	No LOPS, no PAD, no bony deformity	Patient education	Seen annually
1	LOPS ± bony deformity	Patient education, specialized footwear considered, possible surgical intervention for deformity	Seen every 3–6 months
2	PAD ± LOPS	Specialized footwear considered and vascular consultation/referral	Seen every 2–3 months
3	History of ulcer or amputation	Patient education and vascular referral if PAD present	Seen every 1–2 months

Note. LOPS = loss of protective sensation; PAD = peripheral arterial disease.

may be shortened for healthcare professionals outside of podiatry to fit within the patient visit but evaluate quick pertinent findings such as pulses, foot deformity, and LOPS, as seen in Table 3. This brief evaluation may aid the physician, nurse, or other healthcare professional to assess and refer the patient to a podiatrist or other needed physician. The diabetic foot assessment should not be an afterthought in diabetic care but a key component to the whole care of the patient with diabetes and his or her quality of life.

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