



Section 8: Neuropathies and Foot Care

Concern	Care/Test	Frequency
Neuropathies and Foot Care	<ul style="list-style-type: none"> ▪ Assess/screen for neuropathy (autonomic/DPN) ▪ Visual inspection of feet with shoes and socks off ▪ Perform comprehensive lower extremity/foot exam ▪ Screen for PAD (consider ABI) 	<p>Type 1: Five years after diagnosis, then annually</p> <p>Type 2: At diagnosis, then annually</p> <p>Each focused visit; stress daily self-exam</p> <p>At diagnosis, then annually</p> <p>At diagnosis, then annually</p>

MAIN TOPICS INCLUDED IN THIS SECTION:

- Classification of Diabetic Neuropathy
- Distal Symmetric Polyneuropathy
- Autonomic Neuropathy
- Peripheral Arterial Disease
- Screening: Routine Visual Inspection and Comprehensive Foot Exam
- Assessing Vibration Perception with Tuning Fork
- Risk Categorization
- Ulceration
- Infection
- Charcot Foot
- Referral to a Podiatrist and Coordination of Care
- Vibration/Sensation Resources
- Additional Resources
- References

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Diabetic neuropathy is an anatomically diffuse process that affects sensory and autonomic fibers. It has a range of clinical manifestations of which pain and numbness in the lower extremities is the most well-known. Both sensory and autonomic neuropathy can cause significant morbidity, disability, and decreased quality of life.

The prevalence of neuropathy increases with the duration of diabetes and the duration and severity of hyperglycemia. Primary health care providers need to emphasize optimal glycemic control and tobacco cessation as important factors in preventing and slowing neuropathy and peripheral vascular disease.

Neuropathy is considered a progressive disease that affects nerves and can be asymptomatic. Neuropathy may not be evident for several years after the onset of diabetes (especially in type 1 diabetes) but may be present at diagnosis in type 2 diabetes. Screening for both distal symmetric polyneuropathy (DPN) and autonomic neuropathy should take place annually beginning five years after diagnosis for people with type 1 diabetes and at diagnosis for people with type 2 diabetes.

A discussion of peripheral arterial disease (PAD) is also included in this section because poor blood flow to the lower extremities exacerbates the potential complications of sensory diabetic neuropathy such as ulceration and infection by impairing wound healing. Together, PAD and DPN set the stage for lower extremity amputations in people with diabetes. Primary health care providers need to emphasize optimal glycemic control and tobacco cessation as important factors in preventing and slowing neuropathy and PAD.

Classification of Diabetic Neuropathy

Clinically, neuropathy is diagnosed and defined through symptoms, signs, and objective measures and classified into syndromes according to the distribution of peripheral nervous system involvement. Specific treatment for the underlying nerve damage related to neuropathy is not currently available. However, there are medications available to reduce symptoms associated with sensory and autonomic neuropathy. Improved glycemic control and reduced variations in blood glucose excursions can slow the progression of neuropathy. Signs and symptoms of neuropathies are presented in Table 8-1.

Sensorimotor Neuropathy

Types of sensorimotor neuropathy include:

- Distal symmetric polyneuropathy (DPN)
- Focal neuropathy
- Diabetic mononeuropathy (cranial, truncal, peripheral nerves)
- Mononeuropathy multiplex
- Diabetic amyotrophy (weakness, excruciating pain of thigh, hip, and buttocks muscles)

Autonomic Neuropathy

Types of autonomic neuropathy include:

- Hypoglycemic unawareness
- Abnormal pupillary function
- Cardiovascular autonomic neuropathy

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- Vasomotor neuropathy
- Sudomotor neuropathy (sweat glands)

Gastrointestinal Autonomic Neuropathy

Type of gastrointestinal autonomic neuropathy include:

- Gastric atony
- Diabetic diarrhea or constipation
- Fecal incontinence

Genitourinary Autonomic Neuropathy

Types of genitourinary autonomic neuropathy include:

- Bladder dysfunction
- Sexual dysfunction

Table 8-1: Signs and Symptoms of Neuropathies

Small-Fiber Sensory	Large-Fiber Sensory	Autonomic
Burning pain	Loss of vibration sensation	Heart rate abnormalities
Cutaneous hyperesthesia	Loss of proprioception	Orthostatic hypotension
Numbness/paresthesia	Loss of or diminished reflexes	Abnormal sweating
Lancinating pain	Slowed nerve conduction velocities	Gastroparesis
Inability to feel pain and temperature sensation		Neuropathic diarrhea or constipation
Ulcers/sores		Sexual dysfunction
Loss of visceral pain		

The remainder of this section focuses on screening for and prevention of sensorimotor neuropathy (distal symmetric polyneuropathy) and autonomic neuropathy.

Distal Symmetric Polyneuropathy

Distal symmetric polyneuropathy (DPN) is the most common type of sensorimotor neuropathy for people with diabetes. This type of neuropathy presents as numbness, tingling, and a sensation of tightness in the legs and/or feet. Neuropathy pain can present itself as a burning sensation, sharp and/or shooting pains, or as a deep aching pain. Symptoms typically begin insidiously in the toes and then advance proximally up the legs. Both small- and large-fiber sensory neurons are involved. Small-fiber sensory neuron involvement results in loss of pain and temperature sensation, leading to increased risk of injury, trauma, ulceration, and infection. Large-fiber neuron involvement leads to a loss of vibratory sensation, proprioception, and absent or reduced deep tendon reflexes. Together, these sensory deficiencies put people at increased risk for traumatic injury, ulceration, infection, and musculoskeletal deformity.

Acute painful neuropathy is a distal sensory polyneuropathy characterized by severe pain in the leg(s), most often worse at night. Frequently, there is a sensitivity to even bed sheets covering the feet. A neurological

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examination often reveals only slight temperature change and sensation loss with little change in the deep tendon reflexes. Painful neuropathy can be seen following significant weight loss and prolonged periods of poor glycemic control. Symptoms can ease with improved glycemic control. Screening for DPN is best accomplished through an **annual comprehensive foot exam**.

Autonomic Neuropathy

Autonomic neuropathy is a family of nerve disorders that manifest in people with type 1 or type 2 diabetes. The risk for autonomic neuropathy increases with age, being overweight or obese, the duration of time a person has diabetes, and how well controlled their blood sugar and blood pressure are over time. Autonomic neuropathy affects nerves that regulate:

- Blood pressure and blood flow
- Flow through the gastrointestinal tract
- Urinary and sexual function
- Perspiration/skin hydration
- Pupil responses to light
- Bone composition of the foot

Some people with nerve damage due to autonomic neuropathy exhibit no symptoms, but primary care providers can screen for autonomic neuropathy during a history and physical exam. Clinical manifestations and symptoms of autonomic neuropathy include:

- Exercise intolerance
- Abnormal heart rate variability and cardiac arrhythmia (e.g., resting tachycardia)
- Orthostatic hypotension (i.e., drop in blood pressure upon standing)
- Swallowing difficulty
- Constipation or diarrhea
- Gastroparesis (i.e., delayed gastric emptying)
- Erectile dysfunction
- Female sexual dysfunction
- Frequent urinary infections or incontinence
- Sweat gland dysfunction (e.g., skin cracks or body temperature regulation problems)
- Vision problems (e.g., difficulty driving at night)
- Foot deformity (e.g., bone and tendon collapse)
- Hypoglycemia unawareness (i.e., not able to sense hypoglycemia)

The two most common autonomic neuropathies are cardiovascular and gastrointestinal. Cardiovascular autonomic neuropathy presents as resting tachycardia (> 100 beats per minute) and orthostatic hypotension (a drop in systolic blood pressure of > 20 mmHg upon standing). These can lead to exercise intolerance and lightheadedness or syncopal episodes. Gastrointestinal autonomic neuropathies include esophageal enteropathy, gastroparesis, constipation, diarrhea, and fecal incontinence. Constipation is the most common gastrointestinal problem and is commonly associated with intermittent diarrhea. With gastroparesis, slow gastrointestinal emptying leads to bloating and esophageal reflux and can be evaluated with a solid-phase gastric emptying test.

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Autonomic neuropathy can also impair the body's ability to react to an inflammatory response, leading to skin ischemia and poor wound healing. Vasodilatation can shunt blood flow from the capillaries and may lead to bone demineralization and osteolysis, both of which contribute to foot deformity. In addition, cracking and fissures associated with decreased skin hydration provides a portal of entry for microorganisms and increases the risk of infection.

Peripheral Arterial Disease

Peripheral arterial disease (PAD) describes the narrowing of arteries, often due to calcification, that reduces blood flow to the extremities. Like coronary artery disease, people with diabetes have a high risk of developing PAD. Hyperglycemia, dyslipidemia, tobacco use, and hypertension are known risk factors for PAD. PAD is found in five percent of people with diabetes only one year after diagnosis. Screening for PAD should be done at diagnosis and then annually; screening includes assessing a person's history of claudication and assessing pedal pulses. Primary care providers should ask about claudication.

PAD is more likely to occur below the knee in people with diabetes due to inadequate blood supply (i.e., ischemia) to the lower limbs. The earliest sign of PAD is intermittent lower extremity (usually calf) pain that begins with walking and resolves with rest. People with PAD often also complain of cold feet. Physical exam findings suggesting PAD include:

- Weak or absent pulses
- Presence of bruits
- Muscle atrophy
- Hair loss
- Thickened toenails
- Smooth and shiny skin
- Reduced skin temperatures
- Ulcers and gangrene

Providers should not rely solely on a physical exam to detect PAD. The ankle-brachial index (ABI) is a simple, reliable, and non-invasive means for screening and diagnosing PAD. This screening test has a sensitivity and specificity of 90% and higher. A diagnostic ABI is recommended for any person with diabetes and symptoms of PAD. An ABI should also be performed on any person with diabetes who is over age 50 or who has risk factors for PAD (e.g., tobacco use, duration of diabetes more than 10 years, high blood pressure, high cholesterol) because PAD is commonly asymptomatic in people with diabetes.

The ABI is the ratio of systolic blood pressure in the ankle to systolic blood pressure in the arm obtained using a hand-held Doppler and blood pressure cuff. The normal range for ABI is 0.9 to 1.2. An ABI < 0.9 signifies PAD. Heavily calcified arteries, as can be seen with longstanding diabetes, chronic kidney disease, and in the elderly, reduce the accuracy of blood pressure cuff readings and make the ABI less reliable. Pulse volume recording (PVR) is a useful adjuvant to the ABI. Unlike ABI, PVR is not affected by calcified arteries. PVR records a waveform that corresponds to blood flow. A PVR wave form which shows a rapid raise and fall with a sharp peak suggests adequate blood flow while a flatter, nonpulsatile waveform can signify PAD.

Screening: Routine Visual Inspection and Comprehensive Foot Exam

Diabetic neuropathy is the leading cause of lower limb amputations. To prevent lower limb amputations and other foot complications, all people with diabetes should receive an annual comprehensive exam and a routine visual inspection of their feet at each diabetes-related visit. Table 8-2 describes the components of a routine visual foot inspection and a comprehensive foot exam.

Table 8-2: Differences between Routine Visual Foot Inspection and Comprehensive Foot Exam

Recommended Exam*	Exam Includes*
<p>Routine Visual Foot Inspection conducted at each diabetes-related visit:</p> <ul style="list-style-type: none"> ▪ Detect presence of acute problems ▪ Reinforce importance of preventive foot health strategies 	<ul style="list-style-type: none"> ▪ Visual inspection of foot, heel, and between toes ▪ Check for injuries, calluses, blisters, fissures, ulcers, and/or other unusual changes ▪ Check for signs of decreased blood supply, such as skin that is thin, shiny, fragile, or hairless ▪ Inspect nails for thickening, ingrown corners, length, and fungal infection ▪ Check socks or hose for discharge ▪ Check shoes for foreign objects ▪ Inquire about and check for appropriate footwear ▪ Educate about self-care of the feet
<p>Comprehensive Foot Exam conducted annually:</p> <ul style="list-style-type: none"> ▪ Determine or re-evaluate person's risk status ▪ Determine need for referral ▪ Determine need for protective foot wear 	<ul style="list-style-type: none"> ▪ Use a 10-gram monofilament to assess sensory impairment and a 128-Hz tuning fork to assess vibration perception. The combined use of both assessment tools has a > 87% sensitivity in detecting peripheral neuropathy by a health care provider. Loss of 10-gram monofilament perception and reduced vibration perception is predictive of foot ulcers. Pinprick sensation, ankle reflexes, and vibration perception threshold can also be used but are less predictive of future complications. ▪ Identify people at risk for foot problems and categorize their level of risk (see Table 8-3) ▪ Identify current problems and changes since last exam ▪ Assess or reassess musculoskeletal abnormalities or deformities; vascular and neurological status; and skin, nail, and soft tissue changes ▪ Assess foot and lower extremity pulses, gait, range of motion, and recommend referrals as necessary ▪ Assess pain level ▪ Develop a management plan ▪ Educate about the importance of glycemic control ▪ Exam serves as a baseline to compare with future exams ▪ Educate about self-care of the feet

* Exam performed by health care provider knowledgeable and experienced in completing a routine visual inspection and/or comprehensive exam.

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These foot examinations can assist health care providers with:

- Early identification of risk
- Early detection, diagnosis, and referral for problems including ulceration, infection, and painful neuropathy
- Early intervention and treatment to prevent problems from worsening
- Teaching self-management and preventive foot care strategies

Self-management education for preventive foot care should include encouraging people to check their own feet daily and contact their health care provider promptly if they have any concerns. A family member/friend or a mirror can help with seeing all parts of the foot. Health care providers can also discuss appropriate footwear and use foot care education as an additional opportunity to reinforce the importance of good glycemic control. According to published studies, people who received foot self-management education and had a foot examination performed by a health care provider were significantly more likely to regularly check their own feet.

Tools such as the ID Pain™ questionnaire, Neuropathic Pain Questionnaire, or painDETECT questionnaire can be useful for identifying painful neuropathy. For a review of screening tools to identify neuropathic pain, see http://www.neurology.wisc.edu/publications/2007/Neuro_7.pdf.

Assessing Vibration Perception with Tuning Fork

Assess peripheral neuropathy using a 128-Hz tuning fork to determine vibration perception. The assessment is abnormal if the person cannot sense the vibration of the tuning fork when it is pressed against the foot. Vibration perception and proprioception use the same nerve pathways. Therefore, as vibration perception decreases, there is an increased risk of falls due to disequilibrium from decreased position sense. The following steps address using a tuning fork to assess vibration perception:

1. Strike the tuning fork to initiate vibration
2. Touch the tuning fork to the medial aspect of the 1st metatarsal head
3. Ask the patient to state when the tuning fork has stopped vibrating. If the patient states that the vibration has stopped before the vibration has stopped in the examiner's hand the test is (-) abnormal.
4. Avoid calluses, which are relatively insensate
5. Document the results with a (+) for normal and (-) for abnormal

Risk Categorization

Determine risk category upon completion of the comprehensive foot exam. A definition of “low risk” and “high risk” for recurrent ulceration and eventual amputation is provided in Table 8-3 along with the suggested minimal management guidelines. People identified as high risk may require a more comprehensive evaluation. Many other foot exam forms and risk categorization schemes exist. The tool titled “Annual Comprehensive Diabetes Foot Exam Form” is located in the Tools Section and is available online: <http://ndep.nih.gov/diabetes/pubs/FootExamForm.pdf>.

Table 8-3: Risk Categories and Management Guidelines for Foot Exam

Risk Category Defined	Management Guidelines
<p>Low Risk Having all of the following:</p> <ul style="list-style-type: none"> ▪ Intact protective sensation ▪ Pedal pulses present ▪ No deformity ▪ No prior foot ulcer ▪ No amputation 	<ul style="list-style-type: none"> ▪ Perform an annual comprehensive foot exam ▪ Assess/prescribe appropriate footwear ▪ Provide education for preventive self-care to person with diabetes ▪ Perform visual foot inspection at every visit
<p>High Risk Having one or more of the following:</p> <ul style="list-style-type: none"> ▪ Loss of protective sensation ▪ Absent pedal pulses ▪ Foot deformity ▪ History of foot ulcer ▪ Prior amputation 	<ul style="list-style-type: none"> ▪ Perform an annual comprehensive foot exam ▪ Perform visual foot inspection at every visit ▪ Demonstrate preventive self-care of the feet ▪ Refer to specialist(s) and an educator as indicated (always refer to a specialist if Charcot foot is suspected) ▪ Assess/prescribe appropriate footwear ▪ Certify Medicare recipients for therapeutic shoe benefits ▪ Explain benefit of prescription footwear/therapeutic shoes and the importance of breaking in new shoes gradually for prevention of foot complications

Source: Feet Can Last a Lifetime: A Health Care Provider’s Guide to Preventing Diabetes Foot Problems.

Ulceration

Peripheral neuropathy is the single largest cause of foot ulceration. Foot ulceration, in turn, is the single most prevalent precursor to lower extremity amputation among people with diabetes. Risk factors for ulceration include structural deformity, trauma, improperly fitted shoes, calluses, prior history of ulceration/amputation, prolonged pressures, limited joint mobility, hyperglycemia, tobacco use, peripheral vascular disease, duration of diabetes, loss of vision, end stage renal disease, and advanced age. The assessment and treatment of foot ulcers is complex. The tool titled “Diabetic Foot Ulceration” provides a summary of the important parameters for both assessment and treatment of foot ulcers and is available in the Tools Section.

Infection

Foot infections are a major cause of hospitalization for people with diabetes and are almost always a factor in lower limb amputations. Foot infections are divided into non-limb-threatening and limb-threatening categories. The assessment and treatment of foot infections is complex. The tool titled “Diabetic Foot Infection” provides a summary of the important parameters for both assessment and treatment of foot infections and is available in the Tools Section.

Charcot Foot

Charcot foot (i.e., neuropathic osteoarthropathy) is a progressive condition characterized by joint dislocation, pathologic fractures, and severe destruction of the pedal architecture. Charcot foot is associated with severe peripheral neuropathy. Charcot foot is frequently dismissed as a sprain or strain, resulting in improper treatment and further weakening of the foot condition. The assessment and treatment of Charcot foot is complex. The tool titled “Charcot Foot” provides a summary of the important parameters for both assessment and treatment of Charcot foot and is available in the Tools Section.

Referral to a Podiatrist and Coordination of Care

Early recognition of lower extremity problems, prompt referral, and aggressive treatment by a multidisciplinary team is necessary. A foot care team may include podiatrists, orthopedic or vascular surgeons, footwear specialists for pedorthic preventive care (e.g., extra depth shoes or inserts), or rehabilitation specialists. Referrals to specialists for co-management and consultation regarding foot care and treatment can help reduce the likelihood of more severe problems. A multidisciplinary approach is recommended for individuals with peripheral vascular disease, foot ulcers, or high-risk feet, especially those with a history of prior ulcer or amputation.

Vibration/Sensation Resources

- The Center for Specialized Diabetes Foot Care, (800) 543-9055
- Medical Monofilament Manufacturing, LLC, (508) 746-7877
- North Coast Medical, Inc., (800) 821-9319
- Sensory Testing Systems, (225) 923-1297
- Health Resources and Services Administration: <http://www.ask.hrsa.gov>, Lower Extremity Amputation Prevention (LEAP) Program (888) Ask-HRSA (275-4772)
- Contact a podiatrist or pharmaceutical representative for possible supplies

Additional Resources

1. Diabetic Foot Disorders: A Clinical Practice Guideline – American College of Foot and Ankle Surgeons: <http://www.acfas.org/cpg/>.
2. Feet Can Last a Lifetime: A Health Care Provider’s Guide to Preventing Diabetes Foot Problems. Includes tools for diabetes foot exams, foot exam instructions, Medicare information, reference and resource materials, and patient education materials: http://www.ndep.nih.gov/diabetes/pubs/Feet_HCGuide.pdf.
3. Take Care of Your Feet for a Lifetime. An easy-to-read, illustrated patient booklet, available in English and Spanish, providing step-by-step instructions for proper foot care: (English and Spanish) http://www.ndep.nih.gov/campaigns/Feet/Feet_overview.htm.
4. Lower Extremity Amputation Prevention (LEAP) is a comprehensive program that can dramatically reduce lower extremity amputations in individuals with diabetes, Hansen’s disease, or any condition that results in loss of protective sensation in the feet: <http://www.hrsa.gov/leap/>.
5. Medicare foot care definitions and billing codes: <http://www.medicarenhic.com/providers/pubs/Foot%20Care%20Billing%20Guide.pdf>.
6. Medicare Physician Quality Reporting System Measures (formerly known as Medicare Physician Quality Reporting Initiative). This page contains information about Physician Quality Reporting System quality measures, including detailed specifications and related release notes for the individual Physician Quality Reporting System quality measures. https://www.cms.gov/PQRS//15_MeasuresCodes.asp.

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