



Neuropathy Testing

One of the challenges of diabetes

by Ron Stoker

The number of people around the world who are suffering from diabetes has increased from 30 million to more than 246 million in the last two decades. Diabetes is claiming millions of lives and taxes the ability of healthcare systems to deal with the epidemic. Diabetes is expected to affect more than 380 million individuals by the year 2025. The five countries with the largest numbers of people with diabetes are shown in Table 1.

Table 1

Country	Number of individuals with diabetes
India	40.9 million
China	39.8 million
United States	23.6 million
Russia	9.6 million
Germany	7.4 million

Experts believe that by the year 2025, the largest increases in diabetes prevalence will take place in developing countries. Each year a further 7 million people develop diabetes.

The following list shows a number of facts about the worldwide problem of diabetes.^{1,2,3}

- ▶ Each year 3.8 million deaths are attributable to diabetes. An even greater number die from cardiovascular disease made worse by diabetes-related lipid disorders and hypertension.

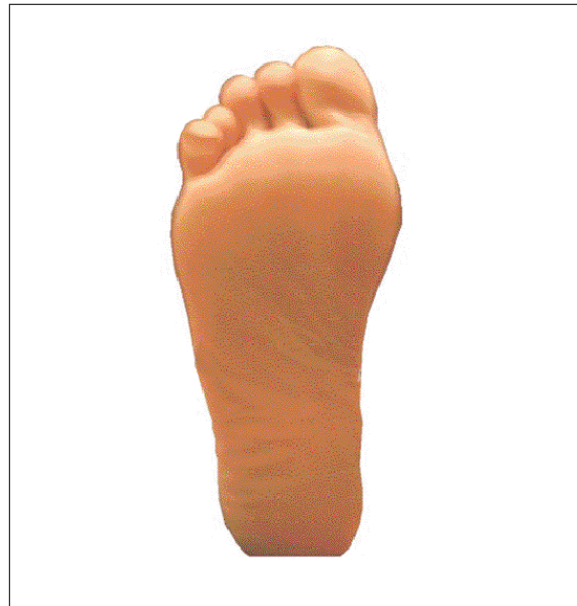
- ▶ Every 10 seconds a person dies from diabetes-related causes.
- ▶ Every 10 seconds two people develop diabetes.
- ▶ Diabetes is the fourth leading cause of global death by disease.
- ▶ At least 50 percent of all people with diabetes are unaware of their condition. In some countries this figure may reach 80 percent.
- ▶ Up to 80 percent of type 2 diabetes is preventable by adopting a healthy diet and increasing physical activity.
- ▶ Diabetes is the largest cause of kidney failure in developed countries and is responsible for huge dialysis costs.
- ▶ Type 2 diabetes has become the most frequent condition in people with kidney failure in countries of the Western world. The reported incidence varies between 30 percent and 40 percent in countries such as Germany and the United States.
- ▶ Ten percent to 20 percent of people with diabetes die of renal failure.
- ▶ It is estimated that more than 2.5 million people worldwide are affected by diabetic retinopathy.
- ▶ Diabetic retinopathy is the leading cause of vision loss in adults of working age (20 to 65 years) in industrialized countries.
- ▶ On average, people with type 2 diabetes will die five to 10 years before people without diabetes, mostly due to cardiovascular disease.
- ▶ Cardiovascular disease is the major cause of death in diabetes, accounting for some 50 percent of all diabetes fatalities, and much disability.
- ▶ People with type 2 diabetes are more than twice as likely to have a heart attack or stroke as people who do not have diabetes. Indeed, people with type 2 diabetes are as likely to suffer a heart attack as people without diabetes who have already had a heart attack.

As shown in the previous table, diabetes continues to increase dramatically in the United States. According to a study conducted in 2007, 7.8 percent of the U.S. population has diabetes. About one-fifth of the diabetic population is unaware that they have diabetes!

Diabetes marked by high levels of blood glucose, also called blood sugar, results from defects in insulin production, insulin action, or both. Diabetes can lead to a variety of serious complications and even premature death. One complication of diabetes is diabetic neuropathy which is a debilitating disorder that occurs in nearly 50 percent of patients with diabetes. It can be found in patients with both type 1 and type 2 diabetes.

Patients typically have one or two types of diabetic neuropathy; sensorimotor and autonomic. Some diabetic patients may only exhibit one type of diabetic neuropathy while others may develop combinations of neuropathies, for example a distal symmetric polyneuropathy or an autonomic neuropathy.

Figure 1. Diabetic patients are at risk for neuropathies resulting in loss of feeling and the risk of chronic ulceration and the amputation of the lower extremities



These diabetic neuropathies cause motor deficits, silent cardiac ischemia, orthostatic hypotension, vasomotor instability, hyperhidrosis, gastroparesis, bladder dysfunction, and sexual dysfunction. Strict glycemic control and good daily foot care are key to preventing complications of diabetic neuropathy.⁴ Research has shown that *systematic and regular foot care can reduce the risk of chronic ulceration and amputation in the lower limb by 50 percent or more.*⁵ This is really important when you look at the statistics of mortality following amputation of a lower extremity (see Table 2).

Table 2.

Number of years following extremity amputation in diabetic patients	Mortality following lower extremity amputation in diabetic patients ⁶
One year	40%
Three years	60%
Five years	80%

The data indicate that once an extremity has been amputated the percentage of patients that die each year after that amputation goes up dramatically. In fact there is an 80 percent mortality rate after five years following

a lower extremity amputation! It is, therefore, extremely important to take proper care of the feet of diabetic.

Proper Foot Care

I think most of us are aware of family members or neighbors who have lost an arm or leg because of diabetes. It is very important that diabetic patients exercise proper daily foot care in order to maximize their potential of keeping all their extremities throughout their lives. Diabetic patients should take time each day to inspect their feet for dry or cracking skin, fissures, or any sign of infection between the toes and around the toenails.^{7,8}

It is also very important for diabetics to wear properly fitted footwear. Many patients end up with an ulcer on the bottom of their feet after purchasing new shoes. New footwear should be broken in slowly to avoid ulcers on the bottom of the feet.

Physicians Should Inspect Patient's Feet on a Frequent Basis

Physicians should frequently examine the feet of diabetic patients to detect evidence of neuropathies. At the very least, physicians should examine patient's feet on at least an annual basis. The American Diabetes Association has recommended a thorough foot examination at least annually for all patients with diabetes. The clinician should examine the patient's feet for skin breaks, red or callused areas, decreased or absent pedal pulses, and delayed capillary refilling, bony deformities, and protective sensation.

In the past these tests were performed using rather archaic methods. For example, the following table shows that patients were tested for the ability of sensing temperature change by using hot or cold water. The test is now performed by using a thermal test stimulator.⁹ The ability to feel pain was assessed using a sharp needle. It was not uncommon in the past for physicians to remove their name badge and use the sharp pin on the back of it to push into the patient's foot. That must not have been very good for infection control issues! Cotton wool was used to assess the ability of the patient to sense touch or pressure. Tuning forks were used to be able to assess the ability of feeling vibration.

Figure 2.
The Neuropen™ is a dual function pocket-size device used to determine loss of sensation.



Newer methods have been used for several years to be able to conduct neurological tests without the potential of infection control or sharps safety issues.

During a physical examination the physician will check the patient's vital signs. Blood pressure in both the supine standing position is taken to check for postural hypotension. A cardiovascular examination is conducted to look for arrhythmias, edema, absent or diminished pulses and delayed capillary refilling. A cutaneous examination is conducted to look for skin or nail changes, red areas or extremity hair loss. A neurologic examination is then performed. See Figure 1 on page 95.

The Neurological Sensory System Examination

The need for regular neurological sensory exams

It is critically important for clinicians to frequently examine the feet of diabetic patients. Foot ulceration causes considerable morbidity among patients with diabetes mellitus and the amputation of a foot or leg remains its most dreaded consequence.¹⁰

Peripheral neuropathy cannot be excluded without regular foot screening in conjunction with symptomatic and clinical assessments. The neurological exam tests the patient for pain sensation, light touch sensation, proprioception or position-sense, stereognosia (difficulty perceiving and identifying objects using the sense of touch), graphesthesia (the ability to recognize writing on the skin purely by the sensation of touch) and extinction.

To test for extinction the physician asks the patient to sit on the edge of an examination table and close their eyes. The patient is touched on the trunk or legs in one place and is then asked to open their eyes and point to the location where they felt the touch sensation. This maneuver is repeated several times, sometimes touching the patient in two different places on opposite sides of their body simultaneously. Normally they will point to both areas but if they do not extinction is present.

Some of the affected patients report paresthesias (pins and needles sensation) in the hands and feet. Others may report dysesthesias (pain) and sensory loss in the affected limbs also.

Research has shown that systematic and regular foot care can reduce the risk of chronic ulceration and amputation in the lower limb by 50 percent or more.

Pain and light touch sensation

In order to test the patient appropriately, the patient is instructed to sit on the examining table or to lie down in a hospital bed with his/her eyes closed. The patient is instructed to say “sharp” or “dull” when they feel a respective object touching them. The patient is shown the object that they are being touched with prior to the testing to help alleviate the fear of being hurt during a physical examination. This pinprick sensation is tested over the plantar aspect of the distal first, third and fifth toe of each foot with the stimulus applied once per site. Patients are then asked to identify when they felt a sensation, and whether it was sharp or dull. Findings are typically scored as sharp, dull or absent for each site.

In addition to the sharp testing a small monofilament is used as a simple noninvasive independent predictor of risk for foot lesions. In one study, the use of monofilament testing detected a 37 percent prevalence of neuropathy in patients with type 2 diabetes. Physicians detected a greater proportion of severe neuropathy than mild/moderate neuropathy.

Neuropen™ and Neurotips™

Neuropen, manufactured by Owen Mumford, is an effective aid to screening programs. It is the first dual purpose, pocket-size device designed to provide a safe and reliable test. It combines two calibrated tests enabling the clinician to identify those patients most at risk of foot ulceration, when used in conjunction with symptomatic and clinical assessments. See Figure 2 on page 96.

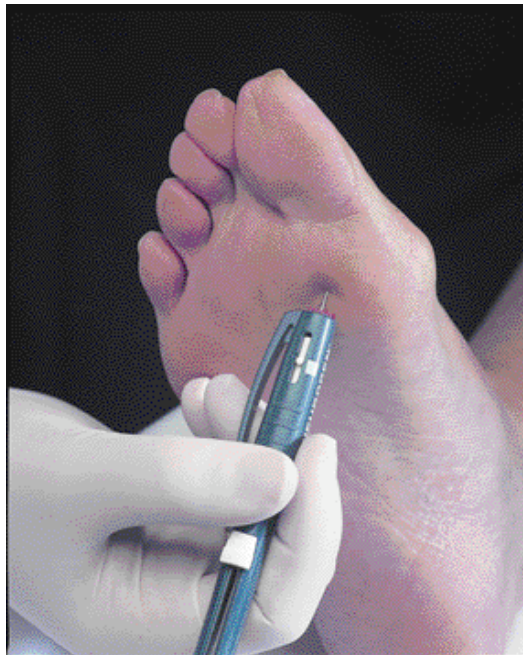
At one end of the Neuropen is a monofilament. The 10g monofilament test assesses touch/ pressure sensation in large nerve fibers. It enables clinicians to map areas of reduced pressure perception by exerting a specific repeatable force on the test site. The 10g monofilaments are replaceable providing the user with a reliable and reproducible test. This is very

important to assess patients who do not have the ability to feel the monofilament. Patients with an inability to detect pressure from such a filament have been shown to have a five-fold increased risk of foot ulceration.¹¹

The 10g monofilament is used to test the protective touch/pressure sensation. The monofilament is fully extended by sliding the button to the end of the device until a click is heard. The end of the monofilament is wiped with an alcoholic wipe or antiseptic solution. The monofilament is pressed at a 90-degree angle to the skin surface and the pressure is increased until the monofilament bows. This is held in this position for one to two seconds. Patients that are unable to detect the monofilament are at a seven-fold risk of foot ulceration.

At the other end of the Neuropen is the Neurotip—a sterile, single-use neurological examination pin that eliminates the risk of cross infection. The Neurotip is semi-sharp examination pin used for sharpness testing which reduces the risk of skin puncture particularly on fragile skin. See Figure 3.

Figure 3. The Neurotip provides a semi-sharp tool that can repeatedly place a 40g force onto the skin to assess sensation to sharpness.



It is used to assess the reduced sensation to sharpness/pain in small nerve fibers. Using a Neurotip within a Neuropen ensures that a quantifiable force of 40g can be exerted safely onto the skin, providing a standardized test to identify patients with a decrease in sensation to sharpness. This provides

It is critically important for clinicians to frequently examine the feet of diabetic patients.

the clinician with a safer tool for testing pain sensation, as the chance of piercing the skin with this standardized force is minimal. It has a removable cap and the red and white colors can provide contrast when used for peripheral vision testing. See Figure 4.

Figure 4. The Neurotip is a safer tool for testing pain sensation. The red and white colors provide contrast when used for peripheral vision testing.



Assessing protective pain/sharpness sensation is easy to do with the Neuropen because it is a calibrated device. The spring mechanism is calibrated to exert a force of 40g, which will help to identify patients with a loss of pain sensation. A Neurotip must first be inserted into the Neuropen. Take an unused Neurotip and hold by the cap. Press it firmly down into the Neurotip holder of the Neuropen as far as it will go. Twist off the Neurotip cap. Press the Neurotip at a 90-degree angle to the skin surface until the marker is within the 40g marker zone. The pen is held in this position for one to two seconds; the patient should then be asked if they can detect a sharp sensation. At the conclusion of the test the Neurotip is removed from the Neuropen and discarded into an approved sharps container.

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Comparative Sensory Testing

Neuropen can be used to assess whether the patient can distinguish between a touch stimulus (monofilament) and a sharp stimulus (Neurotip).

The patient should be randomly tested with either the Neurotip or the monofilament by inverting the pen and asking the patient to identify which stimulus they feel. A normal individual will easily discriminate between these sensations—an inability to distinguish identifies patients at risk of peripheral neuropathy.

Both the monofilament and the Neurotip are single use and can be thrown out after each examination which provides for a neurological examination without the risk of cross infection.

More information on the Neuropen and Neurotip can be obtained by visiting the Owen Mumford Web site at <http://www.owenmumford.com/us/range/26/neuropen.html>, calling 800.421.6936 or e-mailing info@owenmumfordinc.com. †

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