# A user's guide to foot screening. Part 1: Peripheral neuropathy

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**ARTICLE POINTS**

1 Neuropathy due to diabetes is a common foot complication and symptoms are symmetrical.

2 Asking about but failing to examine a patient's feet fails to grasp the significance of neuropathy.

3 Three screening tools are discussed: light pressure, vibration perception and neuropathy scoring systems.

4 The 10 g monofilament is recommended for the light pressure test, the 128 Hz tuning fork for vibration perception and the NDS or NSS for neuropathy scoring.

5 Detecting peripheral neuropathy is probably the most important first step towards preventing neuropathic foot ulcers.

**KEY WORDS**
- **Peripheral neuropathy**
- **Light pressure**
- **Vibration perception**
- **Neuropathy scoring systems**
- **Screening**

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## Introduction

**This article is one of a series of three that aims to provide a clear, simplistic and practical approach to diabetic foot assessment. Each of the three articles will focus upon a particular aspect of foot examination and although they will appear individually they should be combined together to give an overall approach to foot examinations. This article focuses upon identifying the at-risk foot due to peripheral neuropathy. The intention is to provide a simple foot guide to examination for everyday use by clinicians that is derived from evidence-based literature.**

Diabetic peripheral neuropathy can be defined as: 'The presence of symptoms and/or signs of peripheral nerve dysfunction in people with diabetes after other causes have been excluded.' (Boulton et al, 1998).

Peripheral neuropathy is perhaps the most common (approximately 50%) and a familiar complication that affects the feet of people with diabetes (Kumar et al, 1994). Prevalence of neuropathy has been shown to increase with diabetes duration (King and Rewers, 1993). Furthermore, up to 26% of people with type 2 diabetes may have neuropathy at diagnosis (Young et al, 1993). Thus, screening for neuropathy is important at the time of diagnosis in this patient group.

Evidence would suggest that up to 15% of people with diabetic neuropathy develop an ulcer in their lifetime (Bild et al, 1989). Reducing ulcer occurrence is particularly important as foot ulcers precede non-traumatic lower limb amputations in 85% of cases (Pecararo et al, 1990). Once these lesions have occurred, their impact on patients and healthcare resources are significant. The estimated cost of treating a foot ulcer in the community was calculated to be approximately £3600 in 1997 (York Health Consortium, 1997) and a recent 2001 conservative estimate of costs for ulceration and amputation within the UK was £244 million (Shearer et al, 2003).

Thus, by using the appropriate screening tools to identify people with peripheral neuropathy, structured care pathways can be implemented to help reduce foot ulceration. A multidisciplinary team approach to provide suitable footcare education, footwear advice, annual chiropody, specialist podiatrist review, etc, has been shown to significantly reduce foot lesions (Malone et al, 1989; Boulton, 1995; Barth et al, 1991).

It is important to remember that neuropathy due to diabetes is symmetrical, which means it occurs in both feet and legs. Therefore, if neuropathy is found on one side only suspect other causes, such as lower back problems, e.g. sciatica.

There are some basic rules that need to be understood and followed every time a patient is examined:

- Always explain why and what you are doing, using language that is clear, precise and easy to understand, before you perform each test.
- Demonstrate each test on another area of the body where there is not likely to be any sensory loss, ensuring that the patient describes the sensation they perceive for each test.
- If there is any doubt about a response repeat the test several more times.
- When you have completed your testing

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1 Asking a patient if their feet are okay without examining them fails to grasp the significance of neuropathy.

2 Several screening tools are commonly used to detect neuropathy. Three tools are described here: vibration perception, light pressure and the neuropathy disability score.

3 Not all 10 g monofilaments generate 10 g of linear pressure so it is important to obtain the most reliable ones.

make sure you share the results with the patient. This reinforces the concept of patient empowerment and self-care.

- The patient must be relaxed and in a warm environment.
- Following each test you must record your findings before starting the next one. Always repeat the test where negative results have been observed to verify their accuracy.
- It is important not to help, prompt or lead the patient's responses.
- Demonstrating the inability to feel pain is a particularly powerful educational tool that is sometimes useful in motivating awareness and stimulating patient empowerment.

Simply by asking a patient if their feet are okay without examining them fails to grasp the significance of neuropathy. This approach also reinforces patient perception that feet are not important or at risk – a concept that when established is almost impossible to break.

## Testing for neuropathy

There are several screening tools that are commonly used to detect neuropathy, some of which are expensive and time consuming while others are less so but may be more subjective.

**Table 1. Commonly used tests for neuropathy in clinical practice**

- Cotton wool (for light pressure)
- 128 Hz tuning fork (for vibration)
- Neurothesiometer (measures vibration perception in volts)
- Semmes-Weinstein nylon monofilaments: 1, 10 and 75 g (for light pressure)
- Neurotip (for sharp sensation)
- Neuropen (combines 10 g monofilament and Neurotip on a calibrated spring, all incorporated in a pen-like device)
- Hot and cold metal rods or water-filled test tubes (for temperature appreciation)
- Tendon reflexes (ankle and knee jerk)
- Neuropathy symptom scores
- Neuropathy disability scores

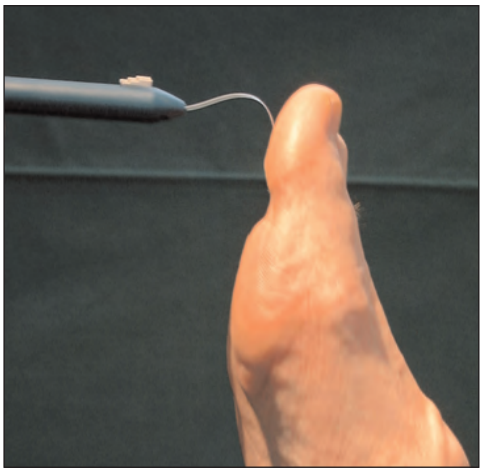

*Figure 1. The 10 g monofilament is recommended as a screening tool as it is quick, reliable and gives reproducible results.*

*Table 1* gives a list of perhaps the most commonly used tests in clinical practice. We have chosen to describe only three of the screening tools mentioned in *Table 1*: these are vibration perception, light pressure, and the neuropathy disability score. The reason for this decision is that these are perhaps the most reproducible and reliable methods to date (Young et al, 1993; Coppini et al, 1998; Smieja et al, 1999; Perkins et al, 2001). If only one method is to be used as an initial screening tool in a busy practice, we would advocate the 10 g monofilament (see *Figure 1*), as it is quick, easy to use, cheap, reliable and reproducible (Smieja et al, 1999).

## Light pressure

Not all 10 g monofilaments generate 10 g of linear pressure so it is important to obtain the most reliable ones. Also they do have a life expectancy and get fatigued if used repeatedly for long periods without allowing the nylon to rest (Booth and Young, 2000). Like all tools, it is only as good as the person using it, the quality of the monofilament, where it is used and how the results are interpreted. The best way to use a monofilament is given in *Table 2*.

### *Areas for testing*

The literature is unclear about the

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1 Sites for testing that are common to virtually all are the plantar surface of the metatarsal heads and the big toe.

2 The more negative responses to light pressure a patient has, the greater the risk of neuropathy.

3 The vibration perception method of testing for nerve damage is relatively easy and reliable – a 128 Hz tuning fork can be used.

4 Vibration perception can decrease with age and other medical conditions, e.g. hypothyroidism.

**Table 2. How to use the 10g monofilament to measure light pressure**

- Bend the monofilament a couple of times at the beginning of each clinic before you use it. This removes any residual stiffness.
- Explain what you are going to do to the patient and apply the monofilament on a sensitive area of their skin, e.g. inside of forearm.
- Ask the patient to close their eyes and say 'yes' every time they feel you touch their feet no matter how lightly they perceive the touch.
- Place the monofilament at 90° to the skin surface and slowly push the monofilament until it has bent approximately 1cm. This should take 1–2 seconds. Do not 'jab' the skin with the monofilament.
- Hold the monofilament in this position for 1–2 seconds and then slowly release the pressure, over 1–2 seconds, until the monofilament is straight. At this point remove the monofilament from contact with the skin.
- Repeat this procedure for all testing sites on both feet and record your findings.
- If during this test you obtain areas where the patient does not respond, repeat the test at the same site twice more and if there is still no response record a negative response.
- Remember if the patient says 'no' while testing they are really saying 'yes'!

definitive sites that must be tested for determining ulcer risk, ranging from 1–14 different sites on each foot (Perkins et al, 2001; Holewski et al, 1988). However, there are sites that are common to virtually all, namely the plantar surface of the metatarsal heads and the big toe (*Figure* 2). The rationale is that these sites most frequently ulcerate. At these sites areas of callus, induration, or scar tissue should be avoided.

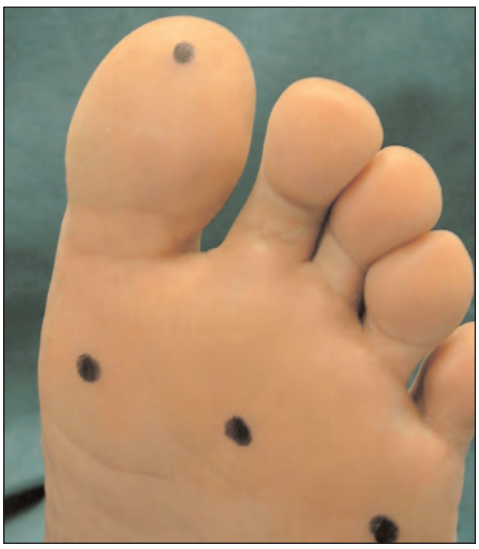

***Figure 2. The big toe and plantar surface of the metatarsal heads are good sites to test using a 10g monofilament.***

There is no clear evidence on how many negative response sites equals an at-risk foot, however, some literature shows that even one site with a negative response (confirmed by several repetitions) on each foot may indicate an at-risk foot (Rith-Najarian, 1992; Birke and Rolfsen, 1998; Perkins et al, 2001), and clearly the more negative responses the greater the risk.

Thus, in summary, when considering screening in a busy clinical environment we would suggest the sites that should be tested are the plantar surfaces of the big toe and a minimum of three metatarsal heads. Neuropathy can be determined by the inability to detect one or more sites on each foot.

### Vibration perception

This method of testing for nerve damage has been used for many years and, like the monofilament, it is relatively easily and reliable. A 128 Hz tuning fork is cheap and widely available, however, a more quantitative method of assessing vibration perception is achieved by the use of a neurothesiometer (Horwell Scientific Laboratory Supplies, UK). Inability to feel vibration produced at 25 volts with this device has shown there to be a 7.7-fold risk of developing a foot

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1 There are several established neuropathy scoring systems, however they may be too time consuming for use in routine clinical practice.

2 The neuropathy disability score uses a neurotip, tuning fork, hot and cold rods and a tendon hammer. A score of three or more out of 10 indicates neuropathy

3 With the neuropathy symptom score, patients are questioned about the presence or absence of various symptoms and a point allocated per symptom. An NSS of three or more was considered abnormal.

ulcer (Young et al, 1993). This device is expensive and therefore may not be viable for use in routine screening clinics. A tuning fork, however, is simple and easier to use.

It is important to remember that vibration perception can decrease with age and other medical conditions, e.g. hypothyroidism and alcoholism. *Table 3* suggests how to use a 128 Hz tuning fork and this is demonstrated in *Figure 3*.

## Neuropathy scoring systems

There are several established scoring systems that have been used to stratify neuropathy severity in people with diabetes, however they are perhaps too time consuming to use in routine clinical practice. Two methods are discussed here.

### *Neuropathy disability score (NDS)*

NDS uses a neurotip, tuning fork, hot and cold rods and a tendon hammer (Young et al, 1993; Abbott et al, 2002). This simple assessment uses a system in which the patient scores one point for each incorrect test, and an extra point if the Achilles tendon reflexes are not determined with reinforcement (*Table 4*). The maximum score for each foot is five

***Figure 3. A 128 Hz tuning fork is simple and easy to use for vibration perception.***

points, and a score of three or more out of 10 suggests neuropathy. In a study of more than 9000 patients, the NDS proved to be the best predictor of foot ulceration (Abbott et al, 2002).

### *Neuropathy symptom score (NSS)*

Boulton et al developed a NSS which is widely accepted and commonly used to

**Table 3. How to use a 128 Hz tuning fork**

- Ensure you explain what you are doing – the patient should feel vibration not pressure or cold.
- Test over a sensitive bony area, such as the elbow.
- Ask the patient to close their eyes and tell you when they feel any vibration (buzzing or humming).
- Hold the tuning fork between your thumb and forefinger, over the ridge area near the base.
- Using the thumb and forefinger of your other hand, press the two limbs together at the top of the tuning fork.
- Sharply pull away your thumb and forefinger from the limbs so that the tuning fork is now vibrating. There should be very little noise.
- Apply the flat surface of the tuning fork to the tip of the big toe. The patient should now feel vibration. Record their response.
- If there is no response repeat this but place the flat edge of the tuning fork on the medial malleolus.
- Repeat this procedure on the other foot.
- Record your findings.

**Table 4. Example of a neuropathy disability score sheet**

| *Neuropathic assessment* | | *Right* | *Left* | *Neuropathy Disability Score* |
|---|---|---|---|---|
| Neurotip discrimination | Hallux-dorsal surface proximal to the toe nail | | | |
| Temperature discrimination | Hallux-dorsal surface proximal to the toe nail | | | |
| Reflexes | Achilles tendon | O/R/2 | O/R/2 | |
| 128 Hz tuning fork | Pulp of hallux | | | |
| | | | *Neuropathy Disability Score total (out of 10)* | |

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1 A neuropathy symptom score of three or more is considered abnormal.

assess neuropathic symptoms (Boulton et al, 1998). Patients are questioned about the presence or absence and possible nocturnal exacerbation of muscular cramps, numbness, abnormal hot or cold sensations, tingling sensations, burning pain, aching pain, and irritation in the lower legs and feet from bedclothes (*Table 5*).

If the patient did not have a given symptom, then a score of zero was given. A score of one was given if the patient reported the symptom, and an additional score of one was given if the patient described nocturnal exacerbation. The summation of all symptom scores gave the NSS. An NSS of three or more was considered to be abnormal.

**Table 5. Example of a neuropathy symptom score sheet**

| **Question** | **Response** | **Score** |
|---|---|---|
| Have you, in the past 6 months, had any pain or discomfort in your legs and feet when you are not walking? | Burning, numbness, tingling = 2<br>Fatigue, cramping, aching = 1<br>Other = 0 | |
| Is this pain and discomfort most felt in the: | Feet = 2<br>Calves = 1<br>Thighs = 0 | |
| Are these symptoms at their worst during the: | Night = 2<br>Various times of day/night = 1<br>Day = 0 | |
| Have these symptoms ever kept you awake at night? | Yes = 1<br>No = 0 | |
| When you get this pain or discomfort is there anything you can do to make it feel better? | Yes, walk = 2<br>No, or stand up = 1<br>All others = 0 | |
| | **Total** (out of 9) | |

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1 The clinical manifestations of autonomic and motor neuropathy are easy to recognise, whereas testing for them is more difficult.

2 The clinical signs of autonomic neuropathy are: dry skin; strong, easy to feel bounding foot pulses; warm feet; dilated dorsal veins; and postural hypotension.

3 The clinical signs of motor neuropathy are high arch feet, clawed toes and altered gait.

4 Informing patients of the outcome of their foot examination is essential and provides a door of opportunity for foot health education.

## Autonomic and motor neuropathy

The clinical manifestations of autonomic and motor neuropathy are easy to recognise, whereas testing for them is more difficult and therefore is not usually undertaken in clinical practice. The clinical signs associated with autonomic neuropathy are:

- Dry skin due to the denervation of the sweat glands. These glands maintain skin moisture on the soles of the feet.
- Strong, easy-to-feel bounding foot pulses. Vasoconstriction is controlled by sympathetic nerve pathways. If these pathways are damaged, arteries lose vasomotor control and remain permanently dilated, being unable to constrict.
- Warm feet – this is due to the increase in skin blood-flow resulting from the above.
- Dilated dorsal veins – there are anastomoses between the arteries and veins, which are used in thermoregulation and are controlled by sympathetic nerve pathways. If these structures become denervated they remain open allowing the free passage of blood from the arteries directly into the veins.
- Postural hypotension – if arteries lose the ability to constrict gravity pulls the blood to the lower limbs. There is a sudden drop in proximal blood pressure, which may cause light-headiness or fainting due to a drop in cranial blood pressure.

The clinical signs of motor neuropathy are high arch feet, clawed toes and altered gait. Two things are important with high arched feet. Firstly, ask how long the patient has had high arches as they may be congenital or have developed early. Secondly, ensure that the arches remain high during weight bearing, as a non-weight-bearing foot that is hypermobile will often appear to have a high arch.

Ask how long the toes have been clawed and see whether they remain so on weight bearing. If the clawed toes are due to muscle wasting as a result of neuropathy you should be able to observe 'hollowing out' between the dorsal tendons.

Patients with altered gait typically show unsteadiness and a characteristically high-stepping gait similar to a drop foot gait.

## Footcare protection following screening

Informing patients of the outcome of their foot examination is essential and provides a door of opportunity for foot health education, which should be simple, unambiguous and practical. Consistency is one of the keys to success. Thus, we would suggest that within each locality only one health

**Table 6. A suggested footcare action guide following neurological assessment of the feet**

| | |
|---|---|
| No history of ulcers, no callus/ deformity or sensory neuropathy | Footcare advice and annual review |
| No history of ulcers, no callus/ deformity but sensory neuropathy present | Footcare advice, routine podiatry referral and annual review |
| No history of ulcers but foot pathologies and deformity with neuropathy | Specialist podiatry and referral or foot clinic and regular reviews<br>Possible footwear referral |
| History of ulcers and neuropathy, Charcot | Specialist podiatry referral or foot clinic and regular reviews<br>Special shoe/insole required |
| Ulceration, blood-stained callus, infection not responding rapidly to antibiotics | Urgent foot clinic referral, frequent dressings, regular review |

education leaflet should be used by all healthcare professionals. *Table 6* gives a rough guide of action to be undertaken following neurological assessment.

## Conclusion

Being able to detect peripheral neuropathy in people with diabetes is probably the most important first step towards preventing neuropathic foot ulceration and lower limb amputations. Using the methods described above should allow for optimum detection. On their own, however, they become ineffectual unless supported by footcare protection systems. Although differences are clearly evident in methods used to detect ulcer risk due to neuropathy, there are several consensus documents that prove helpful and act as clear guides to practitioners, e.g. the International Working Group on the Diabetic Foot international consensus (www.iwgdf.org/consensus/introduction.htm, accessed 22.02.05). Finally, foot screening should be viewed as a continuum, not a one-off occurrence – things change! ■


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### PAGE POINTS

1 Each locality should have only one health education leaflet on footcare, which should be used by all healthcare professionals.

2 Being able to detect peripheral neuropathy in people with diabetes is probably the most important first step towards preventing neuropathic foot ulceration and lower limb amputations.