

# Practical guidelines on the management and prevention of the diabetic foot

Based upon the International Consensus on the Diabetic Foot (2007)

Prepared by the International Working Group on the Diabetic Foot

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## Introduction

Foot complications are among the most serious and costly complications of diabetes mellitus. Amputation of all or part of a lower extremity is usually preceded by a foot ulcer. A strategy which includes prevention, patient and staff education, multi-disciplinary treatment of foot ulcers, and close monitoring can reduce amputation rates by 49–85%. Therefore, several countries and organizations, such as the World Health Organization and the International Diabetes Federation, have set goals to reduce the rate of amputations by up to 50%.

The basic principles of prevention and treatment described in these guidelines are based on the International Consensus on the Diabetic Foot. Depending on local circumstances, these principles have to be translated for local use, taking into account regional differences in socio-economics, accessibility to healthcare, and cultural factors. These practical guidelines are aimed at healthcare workers involved in the care of people with diabetes. For more details and information on treatment by specialists in foot care, the reader is referred to the International Consensus document.

## Pathophysiology

Although the spectrum of foot lesions varies in different regions of the world, the pathways to ulceration are probably identical in most patients. Diabetic foot lesions frequently result from two or more risk factors occurring together. In the majority of patients, diabetic peripheral neuropathy plays a central role: up to 50% of people with type 2 diabetes have neuropathy and at-risk feet.

Neuropathy leads to an insensitive and sometimes deformed foot, often with an abnormal walking pattern. In people with neuropathy, minor trauma – caused for example by ill-fitting shoes, walking barefoot, or an acute injury – can precipitate a chronic ulcer. Loss of sensation, foot deformities, and limited joint mobility can result in abnormal biomechanical loading of the foot. Thickened skin (callus) forms as a result. This leads to a further increase of the abnormal loading and, often, subcutaneous haemorrhage.

Whatever the primary cause, the patient continues walking on the insensitive foot, impairing subsequent healing (Figure 1). Peripheral vascular disease, usually in conjunction with minor trauma, may result in a painful, purely ischaemic foot ulcer.

However, in patients with both neuropathy and ischaemia (neuro-ischaemic ulcer), symptoms may be absent, despite severe peripheral ischaemia. Micro-angiopathy should not be accepted as a primary cause of an ulcer.

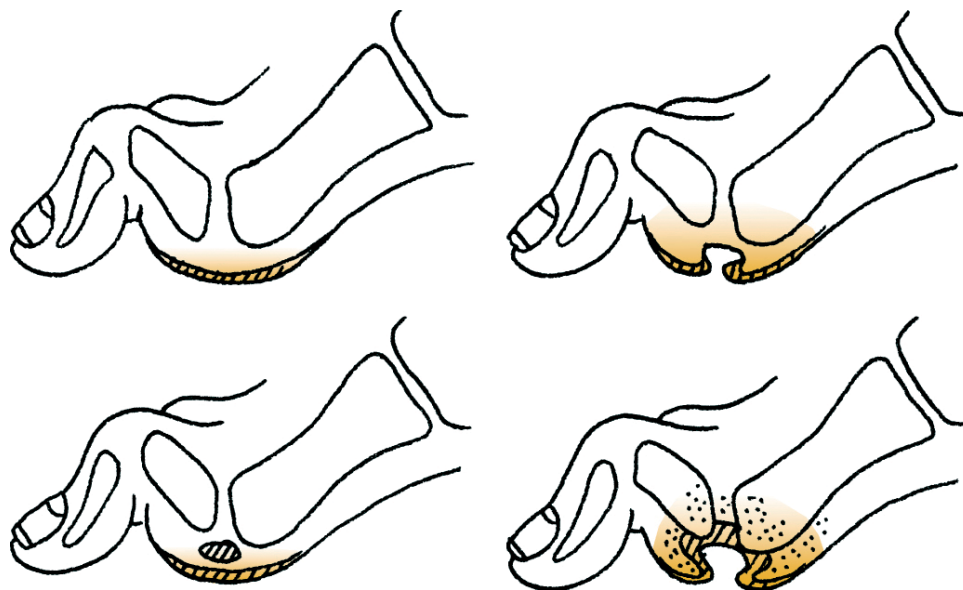


Figure 1. Illustration of ulcer due to repetitive stress

## Cornerstones of foot management

There are five key elements which underpin foot management:

1. Regular inspection and examination of the foot at risk.
2. Identification of the foot at risk.
3. Education of patient, family, and healthcare providers.
4. Appropriate footwear.
5. Treatment of non-ulcerative pathology.

## Regular inspection and examination

All people with diabetes should be examined at least once a year for potential foot problems (Table 1). Patients with demonstrated risk factor(s) should be examined more often – every 1–6 months. Absence of symptoms does not mean that the feet are healthy; a patient might have neuropathy, peripheral vascular disease, or even an ulcer without any complaints. The feet should be examined with the patient lying down and standing up, and the shoes and socks should also be inspected.

## Identification of the at-risk foot

Following examination of the foot, each patient can be assigned to a risk category, which should guide subsequent management (Figure 2).

*Progression of risk categories:*

- Sensory neuropathy and/or foot deformities or bony prominences and/or signs of peripheral ischaemia and/or previous ulcer or amputation
- Sensory neuropathy
- Non-sensory neuropathy

## Education of patients, family, and healthcare providers

Education, presented in a structured and organized manner, plays an important role in the prevention of foot problems. The aim is to enhance motivation and skills. People with diabetes should learn how to recognize potential foot problems and be aware of the steps they need to take in response. The educator must demonstrate the skills, such as how to cut nails appropriately. Education should be provided in several sessions over time, and preferably using a mixture of methods. It is essential to evaluate whether the person with diabetes has understood the message, is motivated to act, and has sufficient self-care skills. An example of instructions for the high-risk patient and family is given below. Furthermore, physicians and other healthcare professionals should receive periodic education to improve care for high-risk individuals.

Table 1. Easy to use foot screening assessment sheet for clinical examination

The foot is at risk if any of the below are present

Deformity or bony prominences	Yes/No
Skin not intact (ulcer)	Yes/No
Neuropathy	
- Monofilament undetectable	Yes/No
- Tuning fork undetectable	Yes/No
- Cotton wool undetectable	Yes/No
Abnormal pressure, callus	Yes/No
Loss of joint mobility	Yes/No
Foot pulses	
- Tibial posterior artery absent	Yes/No
- Dorsal pedal artery absent	Yes/No
Discoloration on dependency	Yes/No
Any others	
- previous ulcer	Yes/No
- amputation	Yes/No
Inappropriate footwear	Yes/No

History and examination

History	Previous ulcer/amputation, previous foot education, social isolation, poor access to healthcare, walking barefoot
Neuropathy	Symptoms, such as tingling or pain in the lower limb, especially at night
Vascular status	Claudication, rest pain, pedal pulses
Skin	Colour, temperature, oedema
Bone/joint	Deformities (e.g. claw toes, hammer toes) or bony prominences
Footwear/socks	Assessment of both inside and outside

Sensory loss

Sensory loss due to diabetic polyneuropathy can be assessed using the following techniques:	
Pressure perception	Semmes-Weinstein monofilaments (10 g, see addendum) The risk of future ulceration can be determined with a 10-g monofilament
Vibration perception	128-Hz tuning fork (hallux, see addendum)
Discrimination	Pin prick (dorsum of foot, without penetrating the skin)
Tactile sensation	Cotton wool (dorsum of foot)
Reflexes	Achilles tendon reflexes

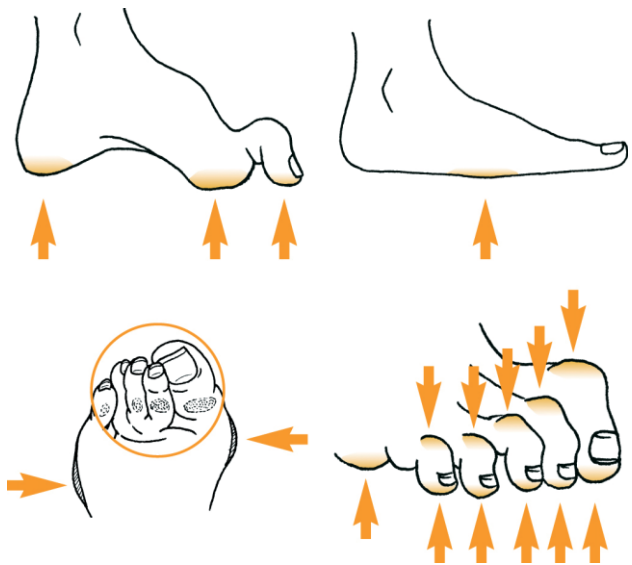


Figure 2. Areas at risk

Items which should be covered when instructing the high-risk patient

- Daily feet inspection, including areas between the toes
- The need for another person with skills to inspect feet, should the people with diabetes be unable to do so (If vision is impaired, people with diabetes should not attempt their own foot care)
- Regular washing of feet with careful drying, especially between the toes
- Water temperature – always below 37 °C
- Do not use a heater or a hot-water bottle to warm your feet

- Avoidance of barefoot walking indoors or outdoors and of wearing of shoes without socks
- Chemical agents or plasters to remove corns and calluses - should not be used
- Daily inspection and palpation of the inside of the shoes
- Do not wear tight shoes or shoes with rough edges and uneven seams
- Use of lubricating oils or creams for dry skin - but not between the toes
- Daily change of socks
- Wearing of stocking with seams inside out or preferably without any seams
- Never wear tight or knee-high socks
- Cutting nails straight across (see Figure 3)
- Corns and calluses - should be cut by a healthcare provider
- Patient awareness of the need to ensure that feet are examined regularly by a healthcare provider
- Notifying the healthcare provider at once if a blister, cut, scratch or sore has developed

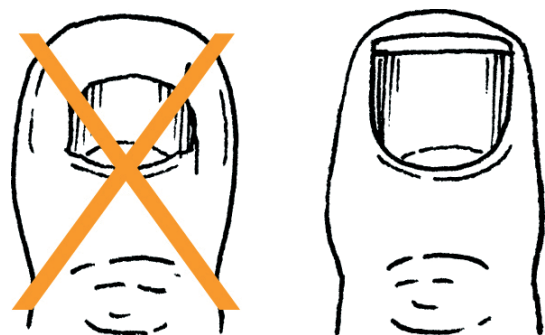


Figure 3. How to cut nails

## Appropriate footwear

Inappropriate footwear is a major cause of ulceration. Appropriate footwear should be used both indoors and outdoors, and should be adapted to the altered biomechanics and deformities – essential for prevention. Patients without loss of protective sensation can select off-the-shelf footwear by themselves. In patients with neuropathy and/or ischaemia, extra care must be taken when fitting footwear, particularly when foot deformities are also present. Shoes should not be too tight or too loose (Figure 4). The inside of the shoes must be 1–2 cm longer than the feet. The internal width should be equal to the width of the foot at the site of the metatarsal phalangeal joints, and the height should allow enough room for the toes. The fit must be evaluated with the patient in standing position, preferably at the end of the day. If the fit is too tight due to deformities or if there are signs of abnormal loading of the foot (e.g. hyperaemia, callus, ulceration), patients should be referred for special footwear (advice and/or construction), including insoles and orthoses.

## Treatment of non-ulcerative pathology

In a high-risk patient callus, and nail and skin pathology should be treated regularly, preferably by a trained foot care specialist. If possible, foot deformities should be treated non-surgically (e.g. with an orthosis).



Figure 4. Internal width of the shoe

## Foot ulcers

A standardized and consistent strategy for evaluating wounds is essential, and will guide further therapy. The following items must be addressed:

**Cause.** Ill-fitting shoes are the most frequent cause of ulceration, even in patients with 'pure' ischaemic ulcers. Therefore, shoes should be examined meticulously in all patients.

**Type.** Most ulcers can be classified as neuropathic, ischaemic, or neuro-ischaemic. This will guide further therapy. Assessment of the vascular tree is essential in the management of a foot ulcer.

If one or more pedal pulses are absent or if an ulcer does not improve despite optimal treatment, more extensive vascular evaluation should be performed. As a first step, the ankle brachial pressure can be measured. An ankle brachial pressure index (ABPI) below 0.9 is a sign of peripheral arterial disease. However, ankle pressure might be falsely elevated due to calcification of the arteries. Preferably, other tests such as measurements of toe pressure or transcutaneous pressure of oxygen (TcPo<sub>2</sub>) should be used. Figure 5 gives an estimate of the chance of healing using the tests. If a major amputation is being contemplated, the option of revascularization should be considered first.

**Site and depth.** Neuropathic ulcers frequently occur on the plantar surface of the foot or in areas overlying a bony deformity. Ischaemic and neuro-ischaemic ulcers are more common on the tips of the toes or the lateral border of the foot.

The depth of an ulcer can be difficult to determine, due to the presence of overlying callus or necrosis. Therefore, neuropathic ulcers with callus and necrosis should be debrided as soon as possible. This debridement should not be performed in ischaemic or neuro-ischaemic ulcers without signs of infection. In neuropathic ulcers, debridement can usually be performed without (general) anaesthesia.

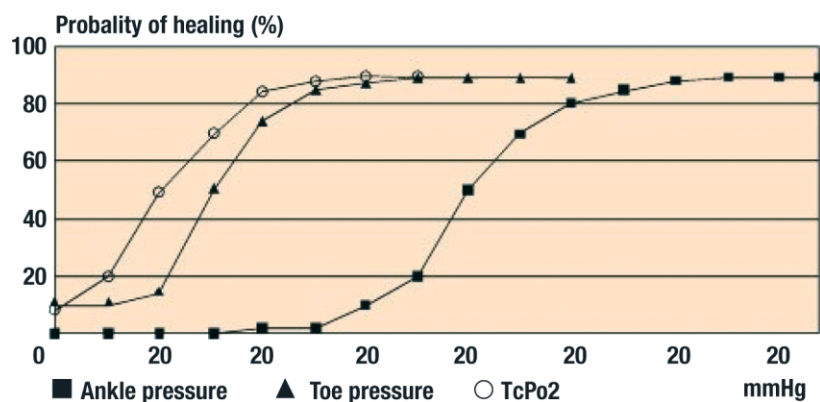


Figure 5. A schematic estimate of the probability of healing of foot ulcers and minor amputations in relation to ankle blood pressure, toe blood pressure, and transcutaneous oxygen pressure (TcPo<sub>2</sub>) based on selected reports

*Signs of infection.* Infection in a diabetic foot presents a direct threat to the affected limb, and should be treated promptly and actively. Signs and/or symptoms of infection such as fever, pain, or increased white blood count/ESR are often absent. However, if present, substantial tissue damage or even development of an abscess is likely.

The risk of osteomyelitis should be determined. After initial debridement, if it is possible to touch the bone with a sterile probe, it is likely that the underlying bone is infected.

A superficial infection is usually caused by Gram-positive bacteria. In cases of (possible) deep infections, Gram stains and cultures from the deepest tissue involved are advised – not superficial swabs. These infections are usually polymicrobial, involving anaerobes and Gram-positive/negative bacteria.

## Ulcer treatment

If treatment is based on the principles outlined below, healing can be achieved in the majority of patients. Optimum wound care cannot compensate for continuing trauma to the wound bed, or for ischaemia or infection. Patients with an ulcer deeper than the subcutaneous tissues should be treated intensively, and, depending on local resources and infrastructure, hospitalization must be considered.

### Principles of ulcer treatment

#### *Relief of pressure and protection of the ulcer*

- Mechanical off-loading – the cornerstone in ulcers with increased biomechanical stress
- Total contact casting or other casting techniques – preferable in the management of plantar ulcers
- Temporary footwear
- Individually moulded insoles and fitted shoes
- Non-weight bearing
  - limitation of standing and walking
  - crutches, etc.

#### *Restoration of skin perfusion*

- Arterial revascularization procedures: results do not differ from people without diabetes, but distal revascularization procedures (angioplasty or bypass-surgery) are needed more frequently.
- The benefits of pharmacological treatment to improve perfusion have not been established.
- Emphasis should be placed on cardiovascular risk reduction (cessation of smoking, treatment of hypertension and dyslipidaemia, use of aspirin).

#### *Treatment of infection*

- Superficial ulcer with skin infection

- debridement with removal of all necrotic tissue and oral antibiotics targeted at *Staphylococcus aureus* and streptococci
- Deep (limb-threatening) infection
  - surgical drainage as soon as possible (emergency referral) with removal of necrotic or poorly vascularized tissue, including infected bone
  - revascularization if necessary
  - broad-spectrum antibiotics intravenously, aimed at Gram-positive and negative micro-organisms, including anaerobes

#### *Metabolic control and treatment of comorbidity*

- Optimal diabetes control, if necessary with insulin (blood glucose <8 mmol/L or <140 mg/dL)
- Treatment of oedema and malnutrition

#### *Local wound care*

- Frequent wound inspection
- Frequent wound debridement (with scalpel)
- Control of exudate and maintenance of moist environment
- Consideration of negative pressure therapy in post-operative wounds

The following treatments are not established in routine management:

- Biological active products (collagen, growth factors, bioengineered tissue) in neuropathic ulcers
- Systemic hyperbaric oxygen treatment
- Silver or other anti-microbial agents containing dressings

Note: footbaths are contra-indicated as they induce maceration of the skin.

#### *Education of patient and relatives*

- Instruction should be given on appropriate self-care and on how to recognize and report signs and symptoms of (worsening) infection such as fever, changes in local wound conditions, or hyperglycaemia.

#### *Determining the cause and preventing recurrence*

- The cause of the ulceration should be determined in order to reduce the chance of recurrences. Ulcers on contra-lateral foot should be prevented and heel protection provided during periods of bed rest. Once the episode is over, the patient should be included in a comprehensive foot care programme with life-long observation.

## Organization

Effective organization requires systems and guidelines for education, screening, risk reduction, treatment, and

auditing. Local variations in resources and staffing will often determine the way care is provided. Ideally, a foot care programme should provide the following:

- Education of patients, carers, and healthcare staff in hospitals, primary healthcare, and the community
- A system to detect all people who are at risk, with annual foot examination of all known patients
- Measures to reduce risk, such as podiatry and appropriate footwear
- Prompt and effective treatment
- Auditing of all aspects of the service to ensure that local practice meets accepted standards of care
- An overall structure which is designed to meet the needs of patients requiring chronic care, rather than simply responding to acute problems when they occur.

*In all countries, at least three levels of foot care management are needed.*

Level 1 – General practitioner, podiatrist, and diabetic nurse.

Level 2 – Diabetologist, surgeon (general and/or vascular and/or orthopaedic), podiatrist, and diabetic nurse.

Level 3 – Specialized foot centre with multiple disciplines specialized in diabetic foot care.

Setting up a multi-disciplinary foot care team has been found to be accompanied by a drop in the number of amputations. If it is not possible to create a full team from the outset, this should be built up step by step, introducing the various disciplines at different stages. This team must work in both primary and secondary care settings.

Ideally, a foot care team would consist of a diabetologist, surgeon, podiatrist, orthotist, educator, and plaster technician, in close collaboration with an orthopaedic, podiatric, and/or vascular surgeon and dermatologist.

## Addendum

### Sensory foot examination

Neuropathy can be detected using the 10-g (5.07 Semmes–Weinstein) monofilament, tuning fork (128 Hz), and/or cotton wisp.

#### *Semmes–Weinstein monofilament*

- Sensory examination should be carried out in a quiet and relaxed setting. First apply the monofilament on the patient's hands (or elbow or forehead) so that he or she knows what to expect.
- The patient must not be able to see whether or where the examiner applies the filament. The three sites to be tested on both feet are indicated in Figure 6.
- Apply the monofilament perpendicular to the skin surface (Figure 7(a)).
- Apply sufficient force to cause the filament to bend or buckle (Figure 7(b)).

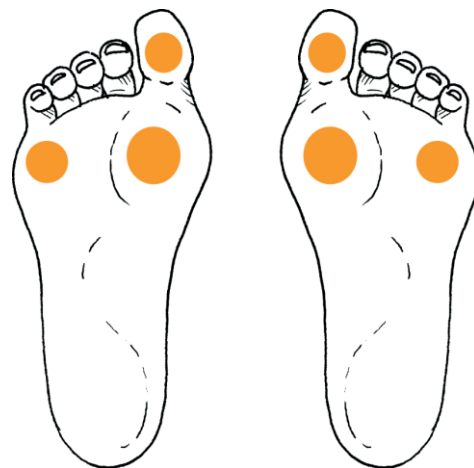


Figure 6. Sites to be tested with monofilaments

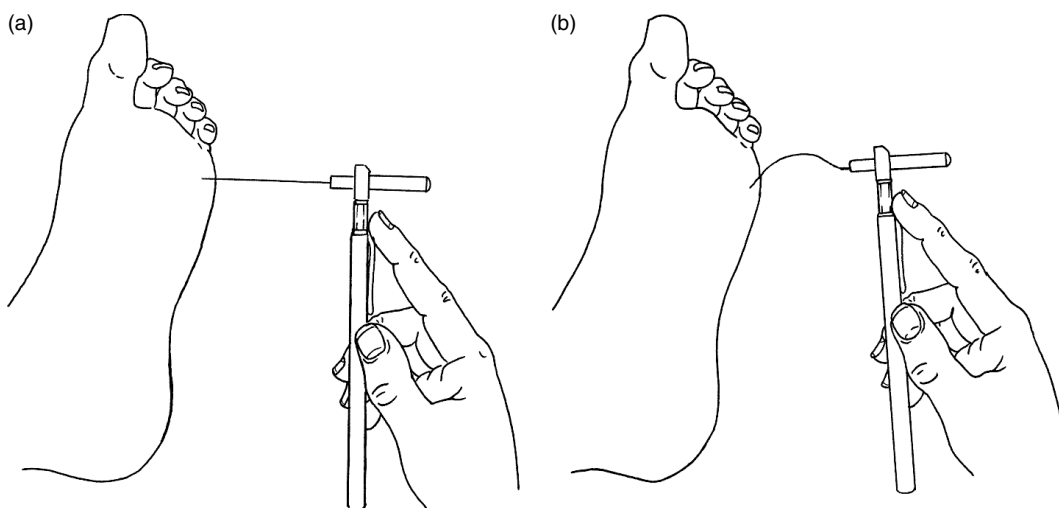


Figure 7. (a) and (b) Application of the monofilaments

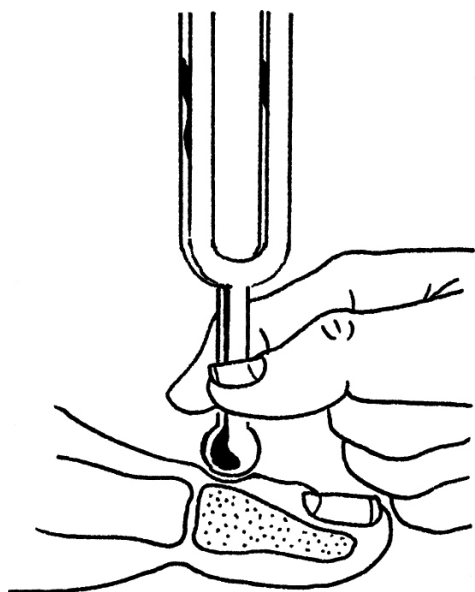


Figure 8. How to use a tuning fork

- The total duration of the approach – skin contact and removal of the filament – should be approximately 2 s.
- Apply the filament along the perimeter of, not on, an ulcer site, callus, scar, or necrotic tissue.
- Do not allow the filament to slide across the skin or make repetitive contact at the test site.
- Press the filament to the skin and ask the patient whether he/she feels the pressure applied ('yes'/'no') and next, where he/she feels the pressure ('left foot'/'right foot').
- Repeat this application twice at the same site, but alternate this with at least one 'mock' application in which no filament is applied (totally three questions per site).
- Protective sensation is present at each site if the patient correctly answers two out of three applications.

Protective sensation is absent with two out of three incorrect answers; the patient is then considered to be at risk of ulceration.

- Encourage the patient during testing by giving a positive feedback.
- The healthcare provider should be aware of the possible loss of buckling force of the monofilament if used for too long a period of time.

#### *Tuning fork*

- The sensory examination should be carried out in a quiet and relaxed setting. First, apply the tuning fork on the patient's wrists (or elbow or clavicle) so that he/she knows what to expect.
- The patient must not be able to see whether or where the examiner applies the tuning fork. The tuning fork is applied on a bony part on the dorsal side of the distal phalanx of the first toe.
- The tuning fork should be applied perpendicularly with constant pressure (Figure 8).
- Repeat this application twice, but alternate this with at least one 'mock' application in which the tuning fork is not vibrating.
- The test is positive if the patient incorrectly answers at least two out of three applications, ('at risk for ulceration') and negative with two out of three correct answers. (A test is positive if it identifies the risk).
- If the patient is unable to sense the vibrations on the big toe, the test is repeated more proximally (malleolus, tibial tuberosity).
- Encourage the patient during testing by giving a positive feedback.

### **Conflict of interest**

The authors have no conflicts of interest.