

# The diabetic foot

Andrew JM Boulton

## Abstract

Foot ulceration in diabetes mellitus is common. Foot problems remain the commonest cause of hospital admission amongst patients with diabetes in Western countries. The lifetime risk of a patient with diabetes developing an ulcer is 25%, and up to 85% of all lower limb amputations in diabetes are preceded by foot ulcers. As many as 50% of older patients with type 2 diabetes have risk factors for foot problems and regular screening by careful clinical examination is essential; those found to be at risk should attend more regular follow-up together with education in foot self-care. The key to management of diabetic neuropathic foot ulceration is aggressive debridement with removal of callus and dead tissue, followed by application of some form of cast to offload the ulcer area. Most ulcers will heal if pressure is removed from the ulcer site, if the arterial circulation is sufficient and if infection is managed and treated aggressively. Any patient with a warm swollen foot without ulceration should be presumed to have acute Charcot neuroarthropathy (CN) until proven otherwise. The optimal approach to reducing ulceration requires regular screening, patient education and a team approach to management, both in the community and in hospital.

**Keywords** amputation; Charcot neuroarthropathy; diabetic neuropathy; foot ulceration; infection; osteomyelitis; peripheral vascular disease

## Definitions and epidemiology

In this contribution, the term ‘diabetic foot’ includes any pathology that results directly from diabetes mellitus or its long-term complications.

Foot problems account for more hospital admissions than do any of the other long-term complications among patients with diabetes. An understanding of the causes of these problems enables early recognition of patients at high risk. It has been shown that up to 50% of amputations and foot ulcers in diabetes can be prevented by effective identification and education.

Foot problems occur in both type 1 and type 2 diabetes and it has been estimated that the lifetime risk of a patient developing a foot ulcer is 25%.<sup>2</sup> Ulcers are more common in men and in patients over 60 years of age. A large population-based study of more than 10,000 patients in the north-west of England reported that 5% had past or present foot ulceration and almost 67% had one or more risk factors: the annual incidence of ulceration in these diabetic patients was 2.2%.<sup>3</sup> Foot ulcers are more common in Caucasians than in Asian or Afro-Caribbean patients.<sup>4</sup> Foot ulceration also appears to be associated with social deprivation.

Foot lesions may be the presenting feature of type 2 diabetes and any patient with a foot ulcer of undetermined cause should be screened for diabetes.

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## What's new?

- A recent randomized trial suggested that for localized osteomyelitis in the diabetic foot, antibiotic therapy alone may be equivalent in terms of outcome to local surgical intervention<sup>1</sup>

## Pathogenesis of foot ulceration

Foot ulceration occurs as a result of trauma (often unperceived) in the presence of neuropathy<sup>5</sup> and/or peripheral vascular disease<sup>6</sup> (Figure 1). Contrary to popular belief, infection is not a primary cause of foot ulcers, but is a secondary phenomenon following ulceration of the protective epidermis.

Advanced somatic neuropathy results in insensitivity, facilitating trauma, and altered proprioception and small-muscle wasting (in the presence of limited mobility in the sub-talar and mid-foot joints), which lead to altered loading under the foot on standing and walking.

This combination of insensitivity and high pressures applied to the foot places the patient at great risk of neuropathic ulceration. Such patients usually have peripheral autonomic dysfunction, which, in the absence of peripheral vascular disease, results in increased resting blood flow; it should be noted that warm, insensitive feet are very much at risk. This ‘autotomectomy’ also leads to dry skin that cracks and fissures, and repetitive high pressure leads to formation of callus tissue beneath weight-bearing areas. Recent research has shown that the presence of callus in an insensitive foot is highly predictive of subsequent foot ulceration.

Peripheral vascular disease is more common in patients with diabetes and is a major factor in the aetiology of ulceration.<sup>6</sup> Pure ischaemic ulcers probably represent only 10% of diabetic foot lesions; 90% are caused by neuropathy, alone or with ischaemia. In recent years, the incidence of neuro-ischaemic problems has increased, and neuro-ischaemic ulcers are now the most common lesions seen in most UK diabetic foot clinics: similarly, in Europe, peripheral vascular disease was present in 49% of foot ulcers with infection present in 58%.<sup>7</sup>

## Identification of the at-risk foot

Careful inspection and examination of the foot is an integral part of the annual medical review that all patients with diabetes should expect. The clinician should never rely on symptoms alone to identify high-risk patients; 50% of patients with insensitive feet have no previous history of neuropathic symptoms, and claudication may not be prominent in those with ischaemic feet. Patients at greatest risk of ulceration are those with:

- evidence of neuropathy
- evidence of ischaemia
- foot deformity (e.g. claw toes, Charcot changes)
- callus at pressure areas
- previous history of foot ulcers
- impairment of sight (patients with restricted vision may injure their feet when attempting self-care, nephropathy is more common in patients with retinopathy, and those with end-stage renal disease on dialysis are amongst the highest risk patients for foot ulceration and amputation<sup>8</sup>)

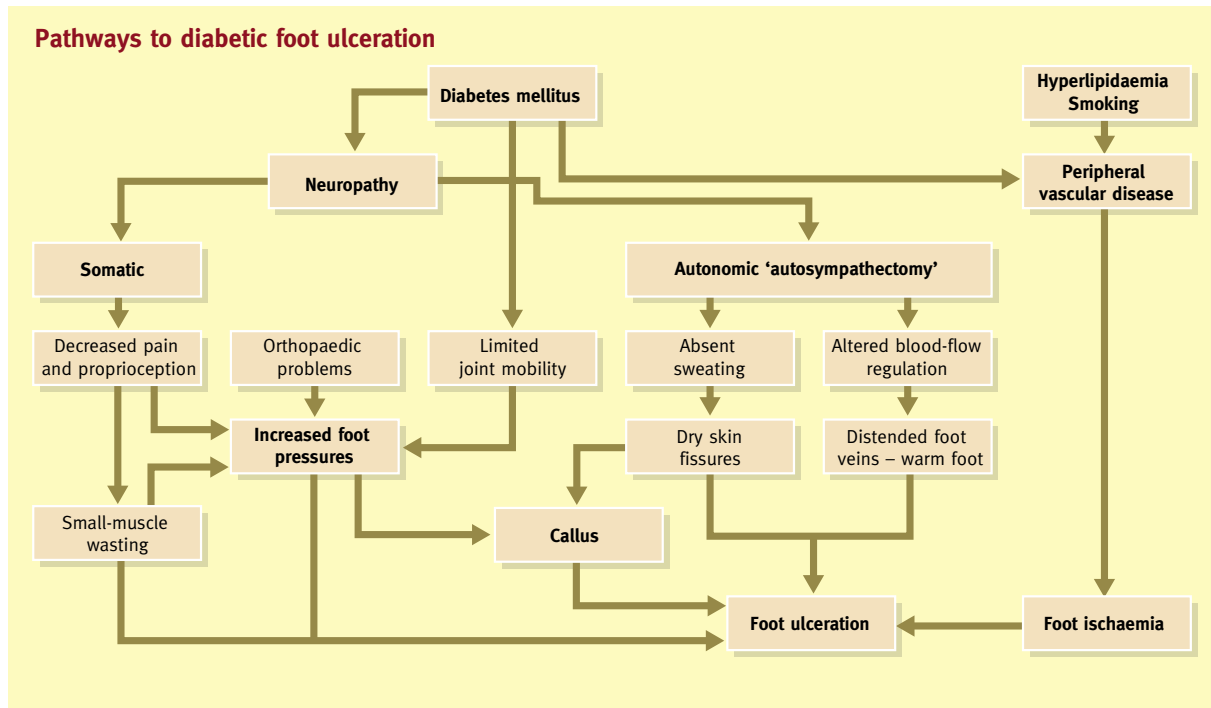


Figure 1

- poor social circumstances (e.g. the elderly, particularly those living alone).

Signs of neuropathy include dry skin, callus formation, distended dorsal foot veins (autonomic dysfunction) and small-muscle wasting (somatic neuropathy). The American Diabetes Association recently proposed that the annual screening for sensory loss should comprise the 10 g monofilament to assess the pressure perception threshold (monofilaments are nylon fibres that, when applied to the skin until they buckle, apply a pressure of 10 g). Sensory loss should be confirmed using an alternative test to detect absence of, for example, pinprick sensation, vibration perception using a 128-Hz tuning fork, temperature perception using hot and cold rods, or vibration perception threshold using a biothesiometer<sup>9,10</sup> (if available). Recently, two even simpler screening tests have been validated. First, the Ipswich touch test whereby the examiner simply touches apices of the first, third and fifth toes and asks if the patient can perceive the touch<sup>11</sup>: in comparison with the 10-g monofilament, this test proved equally accurate in the diagnosis of the 'high-risk' foot.<sup>11</sup> Second, a simple pocket-sized disposable device for testing the integrity of vibration sensation, which has almost perfect agreement with vibration perception threshold and the neuropathy disability score.<sup>12</sup>

Skin temperature and peripheral pulses should also be assessed.

### Prevention of foot problems

Patients without risk factors who have healthy feet should be given general advice on foot hygiene, nail care and the purchase of footwear. Their risk status should be reviewed annually.

Patients with any risk factor should be reviewed more frequently and educated about preventive foot care.

High-risk patients should be advised to:

- wash and inspect their feet daily
- use creams or lotions to prevent dry skin and formation of callus
- always have their feet measured when purchasing shoes
- avoid walking barefoot
- avoid thermal injury (e.g. from hot-water bottles, fires)
- seek medical attention for any foot injury or discomfort, however trivial it may seem
- avoid the temptation to attempt self-treatment of corns, calluses and other disorders.

These simple steps have been shown significantly to reduce the incidence of foot ulceration.

The foot tends to lie 'between specialties', and many centres have developed diabetes foot care teams that may include a diabetologist, surgeon (vascular and/or orthopaedic), chiropodist, specialist nurse and shoe-fitter. A primary role of the team is foot-care education, which is often provided by the chiropodist or nurse.

Much of the screening and primary health education of patients with diabetes is undertaken in primary care. A community foot-care team might comprise a general practitioner, practice nurse and chiropodist, and education for at-risk patients is often provided in this setting. The introduction of multidisciplinary team-work in the community has been shown to result in significant reduction in the number of amputations.<sup>13</sup>

### Diabetic foot ulceration

Despite preventive measures, patients may still develop ulcers and a system of classification is therefore important. In recent years, many new ulcer classification systems have been proposed; one of the most commonly used is that devised at the University of Texas (UT)<sup>14</sup> (Table 1). In this system, grades refer

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