

# Preventing diabetes-related foot ulcers through early detection of peripheral neuropathy



CPD 

Rita McMorrow, Vanessa L Nube,  
Jo-Anne Manski-Nankervis

## Background

Peripheral neuropathy, peripheral arterial disease and diabetes-related foot ulcers are the most important risk factors for future amputation. Up to 50% of people with diabetes have distal symmetrical polyneuropathy as a complication of diabetes. Distal symmetrical polyneuropathy results in loss of protective sensation in the feet, increasing the risk of diabetes-related foot ulceration.

## Objective

The aim of this article is to provide structured guidance for detecting diabetes-related peripheral neuropathy, appropriate referral based on risk assessment and prevention of diabetes-related foot ulceration.

## Discussion

As a result of the often-asymptomatic nature of diabetes-related peripheral neuropathy, general practice is an ideal location for screening all adults with diabetes for loss of protective sensation. Loss of protective sensation in a person with diabetes indicates an at-risk foot. Increased frequency of foot examination, education in self-care, appropriate footwear and referral to podiatry for non-ulcerative foot problems can reduce the development of diabetes-related foot ulcers.

**DIABETIC NEUROPATHY** can encompass distal symmetrical polyneuropathy, autonomic neuropathy and other mononeuropathies and polyradiculopathies. This article will focus on diabetes-related distal symmetrical polyneuropathy (DPN) in adults with diabetes.

DPN affects 26–50% of people with diabetes, a third of whom will have painful DPN.<sup>1,2</sup> Symptoms, if present, develop peripherally in the feet and toes (reflecting diffuse damage to the longest sensory nerves) and can progress in the classical ‘glove and stocking’ distribution.<sup>3</sup> DPN can impair quality of life because of painful symptoms affecting and limiting function, and the associated loss of protective sensation can lead to foot ulceration and amputation.<sup>4</sup> DPN often presents in association with other microvascular complications including retinopathy and albuminuria.<sup>5</sup> The likelihood of DPN and these other complications increases with the duration of diabetes.<sup>6</sup> The trajectory of DPN can be changed by attention to modifiable risk factors, including hyperglycaemia, hypertension and dyslipidaemia.<sup>7,8</sup> Optimising glycaemia provides the best protection against the development of DPN, given that it is currently not a reversible condition.<sup>9,10</sup>

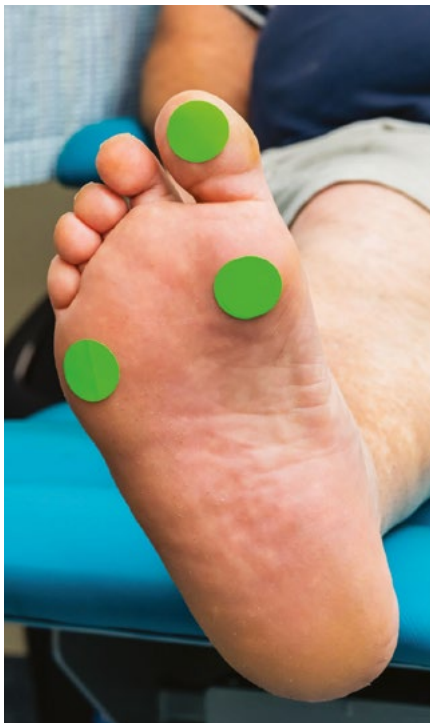
DPN can often progress without symptoms or with symptoms so subtle that DPN goes undetected without

testing.<sup>11</sup> In people with DPN, the risk of foot ulceration is due to a reduced ability to detect painful stimuli.<sup>12–14</sup> Absence of, or reduced, ability to feel an injury from chronic trauma such as ill-fitting footwear or walking on a bony prominence leads to hyperkeratosis, tissue breakdown and ulceration. When protective sensation is lost, burns from heaters or hot water, ingrown or thickened toenails and fungal infections can go undetected and lead to ulceration.<sup>15</sup> Once a foot ulcer develops, the future risk of re-ulceration remains high.<sup>16</sup> Peripheral arterial disease and foot deformities, such as rigid clawed toes, represent the other two most important risk factors for ulceration.<sup>14</sup>

## Multimorbidity and diabetes-related peripheral neuropathy

Most medical management of type 2 diabetes occurs in primary care, where evidence-based treatment can improve outcomes for people with diabetes.<sup>17</sup> Over 90% of people with type 2 diabetes attending general practice in Australia live with multimorbidity.<sup>18</sup> People with type 2 diabetes and multimorbidity spend up to 80 hours per month on self-management.<sup>19,20</sup> Multimorbidity is also common in people with type 1 diabetes, with an even higher amount of time spent on daily self-management.<sup>21,22</sup>

People with multimorbidity may prioritise health issues on the basis of their quality of life, such as prioritising analgesia for painful DPN over optimising glycaemia.<sup>23</sup> Considering the patient's preferences is particularly important in multimorbidity, including assessing treatment burden and exploring how a person's health conditions affect their quality of life. The Problem Areas in Diabetes scale allows for a structured approach to identifying areas of concern related to diabetes management.<sup>24</sup> High levels of diabetes distress affect diabetes self-management and glycaemia, essential factors in preventing higher-risk foot disease.<sup>25,26</sup> People with multimorbidity visit general practice more frequently than those without multimorbidity.<sup>27</sup> This provides opportunities for careful assessment of DPN and other microvascular changes (including annual urine albumin-creatinine ratio and estimated glomerular filtration rate, as well as at least two-yearly assessment for diabetes-related retinopathy)



**Figure 1.** Monofilament testing sites

with development of individualised management.

While long-standing diabetes is a risk factor for neuropathy, other factors such as age, alcohol, vitamin B12 deficiency and thyroid disease can co-exist and contribute to peripheral neuropathy (Table 1). Risk of vitamin B12 deficiency when using metformin increases to almost 20% after five years.<sup>28</sup> Worsening of peripheral neuropathy in people with type 2 diabetes taking metformin may warrant pathology testing of vitamin B12.

### Detection of diabetes-related peripheral neuropathy

Up to a fifth of people with type 2 diabetes will have signs of DPN at the time of diagnosis of diabetes.<sup>29</sup> DPN is a clinical diagnosis, and the extent and progression of neuropathy needs to be documented. As DPN is frequently asymptomatic, guidelines recommend screening annually for evidence of DPN from diagnosis of type 2 diabetes.<sup>11</sup> The National Diabetes Services Scheme has recently released learning modules that can support general practice assessment of foot health.<sup>30</sup> Symptoms and relevant examination findings for a targeted diabetes foot

screening are summarised in Table 2.

A history of foot ulceration, inability to feel a 10 g monofilament or absence of one pedal pulse reliably identify the future risk of foot ulceration.<sup>31</sup>

Monofilament assessment for loss of protective sensation is a crucial component of the physical examination. Current recommendations are for testing three sites on each foot – plantar surfaces of the first and fifth metatarsal heads and the great toe – using a 10 g monofilament until it bends (Figures 1 and 2). Lack of sensation to monofilament at one or two sites suggests a loss of

**Table 1. Causes of peripheral neuropathy in people with and those without diabetes**

A	Alcohol use, autoimmune conditions (eg rheumatoid arthritis, sarcoidosis, systemic lupus erythematosus)
B	Vitamin B12/B6 deficiency
C	Chronic kidney disease
D	Drugs (eg metronidazole; nitrofurantoin; amiodarone; phenytoin; colchicine; chemotherapy agents vincristine, cisplatin and paclitaxel)



**Figure 2.** Monofilament buckling

protective sensation.<sup>32</sup> Testing at sites with significant callus or active ulceration is not recommended as results are uninterpretable. If monofilament testing is unavailable, testing can be performed using the Ipswich touch test. Testing is performed by lightly touching the plantar surfaces of the first, third and fifth metatarsal heads and great toe; with eyes closed, the person with diabetes indicates when touch is felt.<sup>33</sup>

Bony deformities – such as prominent metatarsal heads, hallux valgus and clawed (or hammer) toes – represent areas of high pressure and potential ulceration in people with DPN. In particular, clawed toes are more common because of the wasted intrinsic foot muscles from motor neuropathy.<sup>34</sup> Callus, which occurs in response to chronic pressure over bony areas, is associated with an 11-fold increased risk of ulceration in people with DPN; however, not all areas

of deformity will develop a callus.<sup>35</sup> It is therefore recommended that foot deformity and other non-ulcerative pathology be identified in foot examination as they contribute to foot ulcer risk, particularly in the presence of DPN. The International Working Group on the Diabetic Foot (IWGDF) Risk Stratification System, outlined in Table 3, is based on history and physical examination findings.<sup>36</sup> According to the IWGDF Risk Stratification System, anyone at moderate to high risk requires a referral to a podiatrist. For people with diabetes and any foot pathology, such as callus, ingrown or thickened toenails and fungal infections, podiatry consultation is recommended to prevent foot ulcers.<sup>37</sup> Symptoms of peripheral arterial disease (eg calf muscle pain on exertion) or signs including absent or weak foot pulses in an adult with diabetes warrant referral for non-invasive vascular testing.

Access to podiatry consultation in Australia can be facilitated through Medicare Benefits Schedule chronic disease programs, My Aged Care for people with diabetes aged over 65 years (or over 50 years for Aboriginal and Torres Strait Islander people) or state-funded podiatry services (hospital outpatient clinics and community health services). The latter will prioritise people at moderate and high risk of foot ulceration, and including the risk stratification assessment can facilitate appropriate triage of referrals in these services. For people with active foot ulcers and acute Charcot neuroarthropathy, two major complications associated with DPN, specialist interdisciplinary team-based care is via High Risk Foot Services.

Charcot neuroarthropathy is characterised by fracture and dislocation, which may occur in DPN or other advanced neuropathies, most typically in the foot or ankle. It presents as a unilateral, warm and swollen foot that is painless (or relatively so). It may or may not be preceded by an injury or event such as surgery or prolonged infection.<sup>38</sup> An injury is often not reported, potentially due to loss of sensation. Charcot neuroarthropathy can mimic more common conditions such as cellulitis, soft tissue injury, gout or deep vein thrombosis. If Charcot neuroarthropathy is suspected, it is recommended the person with diabetes minimise weight-bearing immediately and be referred to a local High Risk Foot Service or clinician with expertise in assessing and managing the condition. Successful treatment relies on prompt diagnosis and management in a total contact cast for several months until the inflammation subsides and fractures (if present) heal.<sup>39</sup>

### Practical strategies for preventing foot ulcers and amputation

For people with DPN, minor traumas related to ill-fitting shoes can precede ulceration of the foot, as shown in the case in Box 1. International guidelines have recently been adapted to the Australian context and allow a general practice to make evidence-based recommendations and education as part of diabetes care.<sup>40</sup>

**Table 2. Symptoms and signs of distal symmetric polyneuropathy<sup>41</sup>**

<b>Symptoms</b>	<ul style="list-style-type: none"> <li>• Asymptomatic (50%)</li> <li>• Numbness, tingling, poor balance (large myelinated fibres)</li> <li>• Pain, burning, electric shocks, stabbing (small myelinated fibres)</li> </ul>
<b>Relevant past medical history</b>	<ul style="list-style-type: none"> <li>• Previous foot ulceration</li> <li>• Lower extremity amputation</li> <li>• Peripheral arterial disease or intermittent claudication</li> <li>• History of chronic kidney disease</li> <li>• Smoking history</li> </ul>
<b>Focused examination</b>	<ul style="list-style-type: none"> <li>• Inspection: loss of hair, atrophy, ulcer on toes and metatarsals heads, any areas of pressure, callus, superficial infection, fungal nail infections, wasting of intrinsic foot muscles associated with clawing of toes, anhidrosis, skin fissures</li> <li>• Vascular status: palpation of pedal pulses; refer to Figures 3 and 4</li> <li>• Pressure perception: 10 g monofilament pressure sensation; refer to Figures 1 and 2</li> <li>• Vibration perception: 128 Hz tuning fork at the dorsum of the great toe</li> <li>• Ankle and knee reflexes</li> <li>• Gait assessment</li> </ul>
<b>Patient-reported outcome measure to support assessment of diabetic peripheral neuropathy</b>	<ul style="list-style-type: none"> <li>• Diabetic neuropathy symptom score<sup>41</sup></li> </ul>

Resources for patient education and referrals are listed in Table 4.

For people with DPN, the first step is for people and their families to understand that their foot sensation is reduced. Collaborating with the person with

diabetes to develop a foot action plan includes structured foot care education and footwear review. Initial discussion in general practice (while awaiting podiatry review) for people at moderate and high risk can include safety regarding footwear,

avoidance of thermal injury and how to check their feet to prevent complications. Essential discussion includes the importance of foot protection by not walking barefoot or in socks without shoes, indoors or outdoors. People with diabetes should cut toenails straight across. If there is an increase in weight-bearing activity, people with diabetes should be encouraged to wear appropriate footwear and increase

**Table 3. The International Working Group on the Diabetic Foot (IWGDF) Risk Stratification System and corresponding foot screening and examination frequency<sup>36</sup>**

IWGDF category	Ulcer risk	Risk factors	Re-screen and referrals
0	Very low	No loss of protective sensation and no peripheral artery disease	Screen annually
1	Low	Loss of protective sensation or peripheral artery disease	Re-screen every 6–12 months
2	Moderate	Loss of protective sensation and peripheral artery disease or Loss of protective sensation and foot deformity or Peripheral artery disease and foot deformity	Re-screen every 3–6 months  Podiatry review within 6–8 weeks
3	High	Loss of protective sensation or foot deformity and one of: • history of a foot ulcer • lower limb amputation • end-stage renal disease	Re-screen every 1–3 months  Podiatry review within 2–4 weeks

**Box 1. Case study**

John, aged 57 years, is a man who was diagnosed with type 2 diabetes early in the COVID-19 pandemic. He takes metformin 2 g daily, gliclazide 60 mg daily and dulaglutide 1.5mg weekly. During the COVID-19 pandemic, his diabetes review appointments were via telehealth. John cut his toenails at home, and soon after, he felt a mild burning sensation in his left great toe at night when he took off his pull-on steel-cap boots. On examination, the left great toenail was ingrown, with 1.5 cm of erythema and swelling with purulent discharge. Pedal pulses were palpable bilaterally, and 10 g monofilament pressure sensation was reduced at the left great toe and first metatarsal head. The infection was treated with oral antibiotics, and the ingrown toenail was removed. John was referred for community-based podiatry and changed to lace-up steel-cap boots to help minimise trauma.



**Figure 3.** Dorsalis pedis palpation



**Figure 4.** Posterior tibial palpation

**Table 4. Practical resources**

National Diabetes Services Scheme – Foot Forward modules	<a href="http://www.footforward.org.au/for-health-professionals">www.footforward.org.au/for-health-professionals</a>
National Diabetes Services Scheme – Diabetes and feet: A practical toolkit for health professionals using the Australian diabetes-related foot disease guidelines	<a href="http://www.ndss.com.au/about-diabetes/resources/find-a-resource/diabetes-and-feet-toolkit">www.ndss.com.au/about-diabetes/resources/find-a-resource/diabetes-and-feet-toolkit</a>
Diabetes Foot Risk Stratification and Triage	<a href="http://www.footforward.org.au/wp-content/uploads/2020/11/Risk-of-Developing-Foot-Disease-with-back-page.pdf">www.footforward.org.au/wp-content/uploads/2020/11/Risk-of-Developing-Foot-Disease-with-back-page.pdf</a>
National Diabetes Services Scheme – Fact sheet: Looking after your feet (patient resource)	<a href="http://www.ndss.com.au/wp-content/uploads/fact-sheets/fact-sheet-looking-after-your-feet.pdf">www.ndss.com.au/wp-content/uploads/fact-sheets/fact-sheet-looking-after-your-feet.pdf</a>
Commonwealth My Aged Care scheme	Online at <a href="http://www.myagedcare.gov.au">www.myagedcare.gov.au</a> or phone 1800 200 422
Directory of High Risk Foot Service	<a href="https://nadc.net.au/hrfs-accreditation">https://nadc.net.au/hrfs-accreditation</a>

self-monitoring for any signs of injury. All people with diabetes and loss of protective sensation or peripheral arterial disease are encouraged to perform a daily inspection of their feet, careful drying of feet between toes and application of topical emollients to prevent skin from drying. People with DPN and their families must understand that foot problems can occur without pain and that they should seek treatment promptly for any foot problem.

## Conclusion

All adults with diabetes require annual foot screening to assess for loss of protective sensation. Loss of protective sensation in a person with diabetes indicates an at-risk foot. General practitioners can reduce the development of diabetes-related foot ulcers through increased foot screening, foot self-care education, safe and appropriate footwear and timely referral to podiatry for non-ulcerative foot problems.

## Authors

Rita McMorrow MB BCh BAO, CHIA, FRACGP, Department of General Practice, University of Melbourne, Melbourne, Vic; General Practitioner, Parkville Precinct Medical, Parkville, Vic  
Vanessa L Nube Dip Pod, MSc (Med), Director of Podiatry, Podiatry Department, Sydney Local Health District, Sydney, NSW; The University of Sydney Central Clinical School, University of Sydney, Sydney, NSW  
Jo-Anne Manski-Nankervis BSc (Hons), MBBS (Hons), CHIA, PhD, FRACGP Associate Professor – General Practice, Department of General Practice, University of Melbourne, Melbourne, Vic; Academic General Practitioner, ACADI Diabetes Centre, University of Melbourne, Melbourne, Vic

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**Correspondence to:**  
rita.mcmorrow@unimelb.edu.au

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correspondence [ajgp@racgp.org.au](mailto:ajgp@racgp.org.au)