

The Diabetic Foot

Author: Dr Sharon O'Rourke (Cairns Diabetes Centre)

Topic Reviewer: Dr Dan Ewald

Introduction

Relevance to the CARPA STM

Diabetes is increasingly common throughout the world. The recent AUSDIAB survey conducted in Australia found that 7.5% of adults over the age of 25 had diabetes and an additional 16.8% had impaired glucose tolerance.¹ The prevalence of diabetes in Indigenous populations is even higher with rates of 10 to 20% reported.² In addition, Aboriginal and Torres Strait Islander people with diabetes develop diabetes and its complications at least 20 years earlier than non-Indigenous people. Diabetic foot complications are the commonest reason for hospital admissions.³ People with diabetes are three to seven times more likely to have a non-traumatic amputation than people without diabetes.⁴ The National Diabetes Strategy and Implementation Plan has advocated a 50% reduction in amputations from diabetic gangrene as a target for Australia.⁵

The NHMRC sponsored a National Evidence-Based Guideline for the Management of Type 2 Diabetes Mellitus, Identification and Management of Diabetic Foot Disease.⁶ The guideline is written primarily for general practitioners in recognition that medical management of type 2 diabetes is predominantly carried out in general practice. In rural and remote areas it is often Indigenous health workers and remote area nurses who are responsible for delivering primary care services and will also find the guideline useful. The guideline is summarised in this background paper. Readers are encouraged to source the original document at the Diabetes Australia web page.

Regional epidemiology

In Central Australia, during the six-year period 1992-97, there were 378 hospital separations of people with diabetes, and foot complications for 174 individuals.⁷ The number of hospital separations with diabetic foot complications tripled from 28 per year in 1992 to 90 per year in 1997, and accounted for 11% of all admissions for diabetes in 1997. This equates to a rate increase from 98 to 285 per 100 000 per year for hospital separations with foot complications for people over 15 years of age.⁸ Each year, two thirds of these hospital separations are for people with repeated admissions in the same year. Of the 613 diabetic foot complications, 7% were amputations, 28% surgical debridements, 34% ulcers of the lower limb and 28% were infections of the lower limb.

Aboriginal people with diabetes are over-represented in this group, accounting for 90% of the hospital separations and 90% of the individuals admitted with foot complications. As is seen in other populations males were over-represented, accounting for 52% of separations. The cost of hospitalisations with diabetic foot complications in 1997 was over half a million dollars.⁷

Diabetes-related lower-limb amputation rates for Australia have been reported using the National Hospital Morbidity Database.⁹ The Northern Territory rate was reported as 18.86 (95% CI 15.53-22.19) per 100 000 total population, or about 36 amputations per year. This compares to 2629 +/- 47 amputations in all of Australia per year or 13.97 (95% CI 11.98-15.87) per 100 000 total population. This data needs to be interpreted with caution since it does not distinguish between multiple amputations in the same individual, and it is generally accepted that diabetes is not consistently recorded in hospital records.

In the Central Australian review of hospital separations with diabetic foot complications mentioned above, the foot complications were predominantly of the acute type (90%), amenable to early intervention.⁷

In the past, diabetic foot ulcers and infections often led to amputation. Fortunately, at least 50% of these amputations can be prevented with simple inexpensive measures that are readily implemented in rural and remote locations by a variety of health professionals. Simple screening techniques to identify those at risk of ulceration and amputation, targeted education in basic self care of the feet and careful follow-up of these high-risk patients with regular podiatry and protective footwear will prevent most ulcers. Multidisciplinary management of active lesions will prevent or limit the level of amputation.

The Darwin Hospital High Risk Foot Service has reduced major amputations over three years by almost 50%, from 12 to six major amputations a year.¹⁰

Key issues

The key issues in preventing amputations are:

1. How to identify those at risk
2. How to deliver services to protect feet
3. How to manage active foot lesions to minimise limb loss

How to identify people with diabetes who are at risk of ulceration and amputation

(National Guidelines 1, 2, 3, 4, 5, 6, 7)

The National Guideline has adopted two tiers of risk for diabetic foot problems.

'at risk': people with neuropathy or
peripheral vascular disease or
foot deformity

'high risk': people with foot deformity with
(neuropathy or peripheral vascular disease)
or previous ulcer
or previous amputation

Many factors in addition to neuropathy, vascular insufficiency and deformity interact to result in diabetic foot ulcers. Shoe trauma (rubbing) is frequently the pivotal triggering event that precedes ulceration or amputation. Simple, careful, practical clinical assessment of the person and their feet is the cornerstone to the identification and risk assessment of diabetic foot problems. Detailed neurological examinations and vascular assessments are not necessary to identify individuals at risk of ulceration and amputation.

Peripheral neuropathy is common, with 12.3% present at diagnosis and 30% after 12 years in a UK population¹¹, however, not everyone with peripheral neuropathy is at high risk. Symptoms of pain or altered sensation, signs of decreased vibration perception or absent ankle reflexes do not reliably indicate increased risk of ulceration or amputation. It is important to determine the extent of neuropathy. The 10 g monofilament is a simple, inexpensive device that predicts ulceration with sensitivity of 90% and specificity of 86%.¹² Failure to feel the monofilament at one non-callused plantar site is predictive of future foot ulceration.

[Editor: Not all diabetic patients who develop ulcers or foot infections have neuropathy detectable with the 10 g monofilament. This is said to be 'common' in at least one specialist diabetes practice in the Top End (pers. comm. Dr Di Howard). This may be because of different patterns of injury and infection in the Aboriginal population compared to those in which the monofilament test was validated. The CARPA editorial committee is concerned that too much emphasis may be placed on the monofilament assessment at the expense of full assessment of other aspects of diabetic feet.]

A history of claudication strongly suggests peripheral vascular disease but the absence of claudication does not exclude ischaemia. Pain was completely absent in 73.8% of 104 people with diabetes, peripheral vascular disease and an ulcer.¹³ The presence of palpable pedal pulses is a good predictor of adequate circulation.¹⁴

[Editor: Local experience suggests that skin perfusion may be poor while peripheral pulses are almost always present, even with advanced foot disease. (opinion)]

The presence of ischaemia increases risk of amputation. It increases the risk of a mid-foot or higher amputation 90 times.¹⁵ Previous ulceration proved to be the highest risk factor for development of ulceration (RR 56.8, $p = 0.00001$).¹⁶

Foot deformity – including hallux deformities, claw or hammer toes, bony prominence and Charcot foot – in the presence of peripheral neuropathy with loss of protective sensation was associated with twice the risk of ulceration.¹² The presence of callus (a diffuse hyperkeratotic area usually related to a bony prominence) is highly predictive of ulceration in that area (RR 11.0, CI 2.8–43.2, $p = 0.004$).¹⁶

Previous amputation increases the risk of ulceration and further amputation.^{12,17}

Interventions to protect high risk feet

(National Guidelines 3, 7, 8, 10)

Specific foot care education for people with diabetes improves knowledge and may improve self-care behaviour. The systematic review by Mason et al. recommended additional research to clarify this issue.¹⁸ Inconsistent interventions, major differences in populations studies, different endpoints and short duration of follow-up makes the interpretation and application of studies difficult.

The frequency of foot examinations in people with at-risk feet, but without a current active problem, should be every three to six months (consensus statement only).

Reducing plantar pressures is the basis of treating foot ulcers and preventing ulcers. Plantar pressures may be reduced by 26% by removing callus¹⁹, by 31% with padded socks²⁰, orthotics²¹ and at least 29% with running shoes.²²

Regular podiatry review provides an opportunity to reinforce self-care behaviours and early treatment in people with high-risk feet.²³ Podiatry in combination with protective footwear resulted in a significant reduction in amputations in a randomised controlled trial of people with high-risk feet.²⁴

Extra-deep footwear with custom made insoles reduces plantar pressures by up to 50%.²² This type of footwear is recommended for people at greatest risk (previous ulcer or amputation, deformity and peripheral neuropathy).

A history of an ulcer or amputation indicates life-long risk of recurrent foot ulceration and amputation.

Management of active lesions

National Guideline 11: 'People with diabetes who have foot ulcers or with high risk feet should be cared for by a multi-disciplinary service which should include at least a physician and podiatrist and have ready access to a specialist nurse, orthotist and surgeon.'

Multidisciplinary teams in a number of centres have been successful at reducing amputation rates by at least 50%.^{25,26} A similar approach including a simple recall system reduced hospital admissions, mostly for diabetic foot, by 32% in one year in remote communities of the Torres Strait.²⁷

In a study of 80 first amputees an ulcer preceded 84% of amputations, although many different intermediate pathways were identified.²⁸ Careful monitoring of a ulcer is essential as infection, ischaemia and poor wound healing may lead to amputation.

In a prospective study of 189 Swedish men and women, at five years there was a 49% recurrence of amputation with 85% of new amputations preceded by an ulcer.¹⁷ Recurrence rates such as these highlight the need for lifelong surveillance for people with ulcers or amputations.

A prospective study of Native Americans in a rural setting illustrates the need for a systematic approach to service delivery.²⁹ After an initial reduction in amputation rates of 28% with the introduction of screening for high-risk feet and early treatment, the introduction of a comprehensive management strategy reduced amputations by a further 48%. The strategy included a specialised foot care team, consensus guidelines, standing orders, flow charts, tracking/follow-up and evaluation of the program.

[Editor: The protocol emphasises early, aggressive use of antibiotics in the management of diabetic foot infection/ulcer. This is supported by the predominant role of infection in diabetic foot complications seen in the NT.^{7,30} Giving antibiotics is relatively easy to do but should not be regarded as all that is needed. A search for the precipitating cause (e.g. bad footwear) and relieving pressure and patient education are also needed.

Also note that cheap soft running shoes may be a good choice for many remote diabetic patients. They can reduce planter pressures and protect feet from injury.]

Summary of evidence from the National Evidence Based Guideline for the Management of Type 2 Diabetes Mellitus

There is a direct relationship between glycaemic control and peripheral neuropathy in people with diabetes.³¹ Results of randomised controlled trials in type 1 and type 2 diabetes have shown that improvement in glycaemic control is effective in reducing the risk of development and progression of peripheral neuropathy.^{32,33}

In addition, a healthy lifestyle incorporating good nutrition, regular physical activity and no smoking will improve glycaemic control and decrease the risk of developing peripheral vascular disease.

There is evidence from a systematic review of 20 prospective observational trials that achieving the best possible glycaemic control in people with type 2 diabetes will prevent or reduce the development of peripheral neuropathy.³⁴ Several systematic reviews of studies of non-randomised controlled trials also support the elements of the CARPA guideline.^{18,35,36}

Level II evidence from randomised controlled trials supports the use of:³⁷

- Specific foot-care education for people at risk of foot problems
- Therapeutic footwear combined with podiatry in high-risk individuals
- Orthotics to reduce callous

Evidence from well-designed population-based studies or representative cohort studies is accepted as level II evidence for risk factors and diagnostic studies. Level II evidence is available for:

- Peripheral neuropathy as a risk for foot ulceration and amputation³⁸
- Assessing for peripheral vascular disease by inquiring about symptoms of intermittent claudication³⁹

Level III-2 evidence from comparative studies with concurrent controls and allocation or non-randomised (cohort studies), case-control studies, or interrupted time series with a control group is available for:⁴⁰

- Footwear and padded socks to reduce plantar pressure
- Multidisciplinary teams and foot clinics

Evidence from less-well-designed population-based studies or non representative cohort studies or well-designed case-control studies is accepted as level III evidence for risk factors and diagnostic studies. Level III evidence is available for:

- Regular assessment for PVD⁴¹
- Employing measures to reduce excessive foot pressures in people with neuropathy and foot deformities⁴²
- Using a monofilament to detect loss of protective sensation⁴³
- Assessing for peripheral vascular disease by palpation of pedal pulses⁴⁴

Specialist diabetic foot-care team

All members of the primary health care team, including Aboriginal health workers, can be trained to provide essential foot care services, screening, education for high-risk feet, routine podiatry (including callus debridement). Active problems, ulcers and infection, need to be managed in consultation with an experienced medical practitioner and referred to a Specialist Diabetic Foot-Care Team whenever possible. [Editor: If this is not possible, try to get specialist advice by phone.]

Date of literature review for this article: 30 September 2001

References

- ^{1.} Dunstan D, Zimmet P, Welbourne T, Sciree R, Armstrong T, Atkins R, et al. Diabetes and associated disorders in Australia 2000: The accelerating epidemic. Melbourne: International Diabetes Institute, 2001

2. De Courten M, Hodge A, Dowse G, King I, Vickery J, Zimmet P. 1998 Review of the Epidemiology, Aetiology, Pathogenesis of Diabetes in Aboriginal and Torres Strait Islander Populations. Canberra: Office for Aboriginal and Torres strait Islander Health Services, Commonwealth department of Health and Family Services.
3. Young MJ, Veves A, Boulton AJM. The diabetic foot: aetiopathogenesis and management. *Diabetes Metab Rev* 1993; 9:109-27.
4. Reiber GE. Epidemiology of the diabetic foot. In: Levin ME, O'Neil LW, Bowker JH. *The Diabetic Foot*. St Louis: Mosby Year Book, 1993;1-5.
5. Colagiuri S, Colagiuri R, Ward J. National diabetes strategy and implementation plan. Canberra: Diabetes Australia, 1998.
6. National Evidence Based Guideline for the Management of Type 2 Diabetes Mellitus, Draft for Public Consultation 6 April 2001, Identification & Management of Diabetic Foot Disease. Australian Centre for Diabetes Strategies for the Diabetes Australia Guideline Development Consortium, 2001.
7. Ewald D, Hall G. Trends in Hospital Separations of People with Diabetes and those with Foot Complications in Central Australia 1992-97. Alice Springs: Diabetes Australia, Northern Territory and Territory Health Services, 2000.
8. Ewald D, Patel M, Hall G. Hospital separations indicate increasing need for prevention of diabetic foot complications in Central Australia. *Aust J Rural Health* 2001; 9:275-9.
9. Payne CB. Diabetes-related lower-limb amputations in Australia. *MJA* 2000; 173:352-4.
10. O'Rourke I. Royal Darwin Hospital. Personal communication. (Paper in press.)
11. UKPDS 33. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet* 1998; 352:837-53.
12. Rith-Najarian SJ, Stolusky T, Gohdes DM. Identifying diabetic patients at high risk for lower-extremity amputation in a primary health care setting. A prospective evaluation of simple screening criteria. *Diabetes Care* 1992; 15:1386-9.
13. Faglia E, Favales F, Quarentiello A, Calia P, Clelia P, Brambilla G, Rampoldi A, Morabito A. Angiographic evaluation of peripheral arterial occlusive disease and its role as a prognostic determinate for major amputation in diabetic subjects with foot ulcers. *Diabetes Care* 1998; 21:625-30.
14. McGee SR, Boyko EJ. Physical examination and chronic lower-extremity ischemia. A critical review. *Arch Intern Med* 1998; 158:1357-64.
15. Armstrong DG, Lavery LA, Harkless LB. Validation of a Diabetic Wound Classification System. The contribution of depth, infection, and ischemia to risk of amputation. *Diabetes Care* 1998; 21(5):855-9.
16. Murray HJ, Young MJ, Hollis S, Boulton AJM. The association between callus formation, high pressures and neuropathy in diabetic Foot ulceration. *Diabet Med* 1996; 13:979-82.
17. Larsson J, Agardh C-D, Apelqvist J, Stenstrom A. Long term prognosis after healed amputation in patients with diabetes. *Clin Orthop* 1998; 350:149-58.
18. Mason J, O'Keefe C, McIntosh A, Hutchinson A, Booth A, Young RJ. A systematic review of foot ulcer in patients with Type 2 diabetes mellitus. I: prevention. *Diabet Med* 1999; 16:801-12.
19. Young MJ, Cavanagh PR, Thomas G, Johnson MM, Murray H, Boulton AJM. The effect of callus removal on dynamic plantar foot pressures in diabetic patients. *Diabet Med* 1992; 9:55-7.
20. Veves A, Masson EA, Fernando DJS, Boulton AJM. Studies of experimental hosiery in diabetic neuropathic patients with high foot pressures. *Diabet Med* 1990; 7:324-6.

21. Collagiuri S, Marsdan LL, Naidu V, Taylor L. the use of orthosis devices to correct plantar callus in people with diabetes. *Diabetes Res Clin Pract* 1995; 28:29-23.
22. Kastenbauer T, Sokol G, Auinger M, Irsigler K. Running shoes for relief of plantar pressure in diabetic patients. *Diabet Med* 1998; 15:518-22.
23. Ronnema T, Hamalainen H, Toikka T, Liukkonen I. Evaluation of the impact of podiatrist care in primary prevention of foot problems in diabetic subjects. *Diabetes Care* 1997; 20:1833-7.
24. McCabe CJ, Stevenson RC, Dolan AM. Evaluation of a diabetic foot screening and protection programme. *Diabet Med* 1998; 15:80-4.
25. Dargis V, Panteljeva O, Jonushaite A, Vileikyte L, Boulton AJM. Benefits of a multidisciplinary approach in the management of recurrent diabetic foot ulceration in Lithuania. A prospective study. *Diabetes Care* 1999; 22:1428-31.
26. Larsson J, Apelqvist J, Agardh C, Stenstrom A. Decreasing incidence of major amputation in diabetic patients: a consequence of a multidisciplinary foot care team approach. *Diabet Med* 1995; 12:770-6.
27. McDermott RA, Schmidt BA, Sinha A, Mills P. Improving diabetes care in the primary healthcare setting: a randomised cluster trial in remote Indigenous communities. *Med J Aust* 2001; 21:174(10):497-502.
28. Pecoraro RE, Reiber GE, Burgess EM. Pathways to diabetic limb amputation. Basis for prevention. *Diabetes Care* 1990; 13:513-20.
29. Rith-Najarian S, Branchaud C, Beaulieu O, Gohdes D, Simonson G, Mazze R. Reducing lower-extremity amputations due to diabetes. Application of the staged diabetes management approach in a primary care setting. *J Fam Pract* 1998; 47:127-32.
30. Patel M, Phillips C, Carbaron Y. Frequent hospital admissions for bacterial infections among Aboriginal people with diabetes in central Australia. *Med J Aust* 1991; 155:218-222.
31. Gaster B, Hirsch IB. The effects of improved glycaemic control on complications in Type 2 diabetes. *Arch Intern Med* 1998; 158:134-40.
32. UKPDS 33. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet* 1998; 352:837-53.
33. DCCT The Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med* 1993; 329:977-86.
34. Gaster B, Hirsch IB. The effects of improved glycaemic control on complications in Type 2 diabetes. *Arch Intern Med* 1998; 158:134-40.
35. Mayfield JA, Reiber GE, Sanders LJ, Janisse D, Pogach LM. Preventive foot care in people with diabetes. *Diabetes Care* 1998; 21:2161-77.
36. National Evidence Based Guideline for the Management of Type 2 Diabetes Mellitus, op cit.
37. National Evidence Based Guideline for the Management of Type 2 Diabetes Mellitus, op cit p 75.
38. National Evidence Based Guideline for the Management of Type 2 Diabetes Mellitus, op cit p 40.
39. National Evidence Based Guideline for the Management of Type 2 Diabetes Mellitus, op cit p 66.
40. National Evidence Based Guideline for the Management of Type 2 Diabetes Mellitus, op cit p 86.
41. National Evidence Based Guideline for the Management of Type 2 Diabetes Mellitus, op cit p 44.
42. National Evidence Based Guideline for the Management of Type 2 Diabetes Mellitus, op cit p 50.

43. National Evidence Based Guideline for the Management of Type 2 Diabetes Mellitus, op cit p 60.

44. National Evidence Based Guideline for the Management of Type 2 Diabetes Mellitus, op cit p 66.