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International Diabetes Federation

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## A good year for feet

For a single-theme issue, this *Diabetes Voice* special on the diabetic foot manages to address quite a variety of themes – reported from around the world. Zulfiqarali Abbas and Stephan Morbach report from Tanzania on the impact of diabetes foot complications in the developing regions, where poverty, a lack of health-care provision, and social and cultural factors conspire to compound the damage caused by diabetes complications. The article by Stephanie Wu and David Armstrong describes the optimum clinical procedures for managing a person's diabetes-damaged foot. From Australia, Marg McGill provides a concise and powerful report on the challenges involved in delivering effective foot-care education to prevent distress and disability.

These and the other articles in this special issue reflect the need for a multidisciplinary approach to diabetes foot care and diabetes management in general. It is hoped that the experience, insights and updates provided by the authors will be of interest to all of those involved professionally or otherwise in managing diabetes.

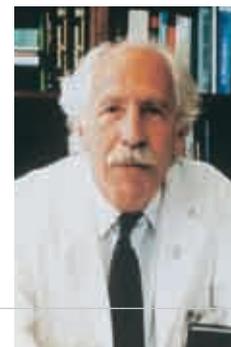
Indeed, the objective of this special issue is to reach other potential specialists in foot care and prevention. For the deepest and most important cuts in the human and economic costs of diabetes-related amputations must be made outside the health-care setting: in the homes and schools and work-places of people with diabetes – while their feet are in perfect condition. It is our mission to ensure that these perfectly healthy feet remain just so.

The overall theme of this special issue reflects the focus of this year's World Diabetes Day campaign. For 12 months we have used various media vehicles, such as press events, congresses, publications – including '*Diabetes and foot care: Time to act*' – and websites, in an attempt to drive home globally a number of key messages about the diabetic foot: that diabetes foot damage represents an already huge burden to people, their communities and their countries – and it is growing; that investing in adequate screening and prevention initiatives and foot-care education is cost-effective in both human and economic terms; that a team-based approach to addressing people's foot problems is the best

way to provide care, and that a combination of the above can reduce the overall number of diabetes-related amputations.

It is not yet time to look back on the 'year of the foot'; the campaign is in full swing and, as I write this column, nearing a time of accelerated activity. Our guest editor for this issue will update us on the achievements of the campaign in due time. Indeed, this has been a particularly busy year for Karel Bakker. He and the members of the IDF Consultative Section and the International Working Group on the Diabetic Foot are key figures in global efforts to raise awareness and improve the provision of diabetes foot care. They are a valuable asset to our community.

While planning in IDF offices for the 2006 and indeed the 2007 campaigns is already underway, activities worldwide on 14 November will signal the climax of this year's World Diabetes Day campaign. Our objective in 2006 will be to highlight the needs of people with diabetes who are vulnerable or underserved. For a number of motives, due to their social status, nationality or even their age, or because of a disability they may have, millions of people around the world are at increased risk of suffering the potentially devastating complications of diabetes. In this the year leading up to our IDF World Diabetes Congress in Cape Town, South Africa, we will more than ever need to tread with care and conviction.



Pierre Lefèbvre is IDF President. He is also Emeritus Professor of Medicine at the University of Liège, Belgium, and Doctor Honoris Causa in six universities in Europe and North America.

A handwritten signature in black ink that reads "Pierre Lefèbvre". The signature is written in a cursive style and is underlined with a single horizontal line.

## Keeping people's feet perfect

Losing a limb is among the most feared of the many disabling complications that can affect people with diabetes – with reason: every 30 seconds, a lower limb is amputated due to diabetes; up to 70% of all leg amputations happen to people with the condition. The objective of this special issue of *Diabetes Voice* is to explain why this is so, how diabetes foot damage occurs, and what needs to be done to reduce the impact of diabetes-related amputations.

Indeed, the impact of limb loss is immense in both economic and psychological terms. In this issue, Jan Apelqvist and Gunnel Ragnarson Tennvall report on the huge drain on economic resources for both society and individuals; up to 20% of total expenditure on diabetes might be attributable to the diabetic foot. Importantly, the authors underline the cost-effectiveness of prevention and recommend a multidisciplinary response to foot problems.

The human costs are also described in this issue: Loretta Vileikyte reports on the impact of the psychological and social factors relating to diabetes foot damage. The degree to which we as health-care professionals are able to empathize with those affected by this condition may have a strong influence on people's behaviour and thus their clinical outcomes – and ultimately their quality of life. A number of the issues that are addressed by Loretta Vileikyte are illustrated in the engaging and enlightening personal story of a man from Senegal with diabetic foot problems.

The majority of diabetes-related lower-limb amputations are preceded by foot ulcers. The most important factors in the development of diabetes foot ulcers – nerve damage, foot deformities, minor foot injuries, infection and vascular disease – are explored in the section of this special issue entitled '*Understanding the diabetic foot*'.

There is a whole spectrum of foot problems. These lesions differ according to the environmental conditions – including climate and geography – in which people live with their diabetes. In another article, Sue Tulley, who works in Bahrain, offers a clear example of the significance of these environmental factors on the advice that is offered by professional health carers.

Indeed, tremendous disparities exist in the standards of foot care provided in countries around the world. Compared to the developed countries, foot problems related to diabetes are more common in developing regions and, as reported by Zulfiqarali Abbas and Stephan Morbach, their impact is exacerbated by poverty and an overall lack of health-care provision.

Surely the most important message – one which is emphasized by all the authors in this issue – is a positive one: the current situation can be changed. It is possible to reduce amputation rates by between 49% and 85% through preventive initiatives, the multidisciplinary treatment of foot ulcers, excellent diabetes management, and appropriate education of people with diabetes and health-care professionals.

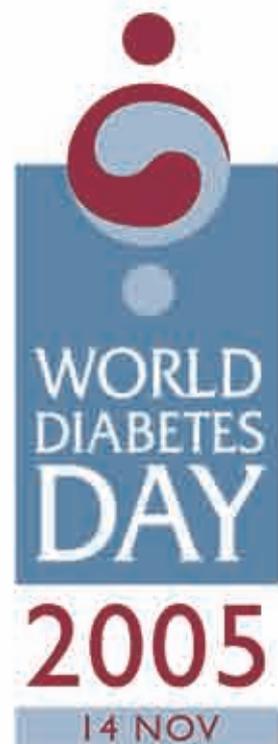
Over the past months, the International Diabetes Federation has repeatedly broadcast this crucial message using a variety of communications tools. The work of the International Working Group on the Diabetic Foot in supporting IDF's global campaign should not go unrecognized. We would like also to extend our gratitude to our industry partners for their backing of this year-long campaign, and in particular Kinetic Concepts Inc (KCI) for their support in publishing this special issue.



Karel Bakker is a specialist in internal medicine, diabetology and endocrinology. He retired from the Spaarne Hospital, Heemstede, the Netherlands in 2002. He is Chairman of the IDF Consultative Section and International Working Group on the Diabetic Foot.

Diabetes  
and  
Foot Care

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# The diabetic foot:

## epidemiology, risk factors and

### *the status of care*

✎ Andrew Boulton

*The development of foot problems is not an inevitable consequence of having diabetes. Indeed, most foot lesions are preventable. However, recent statistics are somewhat depressing: approximately a quarter of all people with diabetes worldwide at some point during their lifetime will develop sores or breaks (ulcers) in the skin of their feet. Moreover, as the number of people with diabetes rises worldwide, there can be little doubt that the burden of diabetes-related foot problems will increase in future years, particularly given that at least one in 10 people at the time of diagnosis of type 2 diabetes has risk factors for foot damage. In this overview, Andrew Boulton summarizes the epidemiology of diabetic foot disease, outlines the risk factors for foot lesions, and describes the current global status of care.*

In the developing countries, foot ulcers and amputations are sadly very common. Often, poverty, a lack of sanitation and hygiene, and bare-foot walking interact to compound the impact of diabetes foot damage. In low-income countries, the lack of access to adequate health care, together with economic and geographical factors, in many cases prevent people with diabetes from seeking medical treatment for foot lesions until these have become grossly infected. In some islands of the Caribbean, for example, where the prevalence of diabetes is approaching 20%, foot lesions and gangrene are amongst the most frequent conditions seen on surgical wards.

**In developing countries, diabetes amputations are very common.**

#### Epidemiology

The diabetic foot is a major medical, social and economic problem worldwide. However, the reported frequency of ulceration and amputation varies considerably. This may be due to differences in diagnostic criteria as well as regionally specific social and

economic factors. In most developed countries, the annual incidence of foot ulceration amongst people with diabetes is about 2%. In these countries, diabetes is the most common cause of non-traumatic amputation; approximately 1% of people with diabetes suffer a lower-limb amputation.

In summary, foot problems remain very common in people with diabetes throughout the world. Indeed, it must be assumed that up to half of these people have risk factors for developing foot ulcers.

### Risk factors for ulceration

In people with diabetes, foot ulcers occur as a consequence of the interaction of risk factors: the diabetic foot does not ulcerate spontaneously. In order to develop initiatives to prevent ulceration and, thus prevent costly and distressing amputations, it is important to understand how and why these ulcers occur.

Nerve damage (neuropathy) is common in diabetes, affecting 20%-50% of people with the condition. Neuropathy may give rise to painful symptoms in a person's legs, which are typically worse at night, or may be completely painless – the person's feet may feel numb. The danger is that the pain and temperature sensations that normally protect our feet from injury may be reduced or lost. Thus, people's feet may be injured without their being aware that a problem exists. Although neuropathy on its own does not cause ulceration, it permits injuries to go unnoticed.

When people with diabetes lose the feeling in their feet, the following injuries commonly occur:

- rubs and ulcers develop, which might become infected, after wearing shoes that are too small
- burns and/or ulcers after stepping into a bath when the water is too hot
- a painless ulcer caused by treading on a sharp object when walking barefoot with no warning signs to rest and treat the ulcer.

### Skin problems

Neuropathy also leads to dry skin and results in the build up of thick, hard skin

(callus) under weight-bearing areas of the feet. Furthermore, walking patterns are often altered; unsteadiness is common in people with diabetes nerve damage. As a result of these factors, some areas on the soles of the feet are forced to resist high pressure when a person walks (see figure). Ulcers may develop under these high-pressure areas.

### Vascular damage

Damage to the blood vessels leading to the legs and feet (peripheral vascular disease) is also more common in people with diabetes compared to those without the condition, and may be present with neuropathy.

In summary, ulcers develop when several risk factors occur together; the people at greatest risk are those with previous ulcers or those who have undergone previous foot surgery. (For a description of the pathophysiology of the diabetic foot, see the article in this issue by Vilma Urbančič-Rovan.)

### Global status

Huge discrepancies exist across the world in the provision of foot care for people with diabetes. Specialists in foot care (podiatrists) – key members of the diabetes team – are found in only 20 countries, including the USA and UK, the Benelux and Scandinavian countries, South Africa, Australia and New Zealand. The majority of countries, and indeed continents, are severely lacking in podiatry services. Similarly, the availability of specialist diabetic foot clinics varies enormously.

In China, which has a population of 1.3 billion, there are reported to be five such clinics; in Brazil, as a result of

Figure: Print-out from a PressureStat foot mat



This example is of someone with neuropathy; the darker areas represent the high pressure areas. This can be used as an educational aid to explain to the person which of the areas under their foot are at most risk of ulceration.

regional and countrywide initiatives such as the 'Save the diabetic foot' campaign, there are more than 60 clinics. This Brazilian programme is an excellent example of the achievements, in terms of enhancement of the provision of health care, that are made possible through co-operation between people with diabetes, health-care professionals and government.

There is increasing evidence that this programme is resulting in the reduction of amputations in a number of centres.<sup>1</sup>

In addition to foot care interest groups such as the Foot Study Group of the European Association for the Study of Diabetes, the Foot Council of the American Diabetes Association and the Grupo Latinoamericano de Estudios de Pé Diabético (GLEPED), a number of countries including Colombia, India and Israel have formed 'diabetic foot societies'.

### Barriers to care

One of the principal barriers to improving diabetes foot care is the failure of health-care professionals to understand the behavioural impact of living without peripheral sensation. Throughout our training in medical, nursing or podiatry school, we health carers are taught how to manage people who 'present with symptoms'. According to the traditional model of treatment, a person comes to us seeking treatment for a physical symptom; a history is taken and a diagnosis made; some form of treatment is prescribed, and hopefully the symptoms resolve.

However, we have no training in managing people who have lost what the late Paul Brand, a doctor working in leprosy, called 'God's greatest gift to mankind': pain.<sup>2</sup> We will only achieve a reduction in neuropathic foot problems if we remember that people with insensitive feet have lost the warning signal that ordinarily brings a person to their doctor.

This is a challenge facing the medical profession: it is difficult for us to understand, for example, that a sensible person with diabetes would buy and wear a pair of shoes that are three

sizes too small and come to our clinic with an extensive shoe-induced ulcer. The explanation, however, is simple: with reduced sensation, a very tight fit stimulates the remaining pressure nerve endings and thus is interpreted as a normal fit. Hence the common complaint when we provide people with specially designed shoes: "these shoes are too loose". It is vitally important that we realize that with the loss of pain comes reduced motivation to heal and prevent injury.

**With the loss of pain comes reduced motivation in the healing and prevention of injury.**

A further barrier to care is formed by the failure of many people with diabetes who suffer from neuropathy to understand the nature of this condition. People with warm feet but a complete loss of feeling may be reassured: warm feet must mean good circulation, which means healthy feet. (This is discussed further by Loretta Vileikyte in this issue).

### Call for action

The words of the inspirational doctor, Paul Brand, come to mind.<sup>3</sup> When attending a conference of the US Department of Health, Brand was asked to make a recommendation on reducing amputations in people with diabetes. Most listeners, expecting an answer promoting vascular surgery or modern medications, were surprised to hear that the key recommendation was a national campaign to encourage health-care professionals to remove patients' shoes and socks and examine

their feet. There is no doubt in my mind that if this advice were applied throughout the world, it would have a major impact on reducing disability and the death from diabetes foot damage.

My call to action is to my colleagues to remove their patients' shoes and socks: every time you see a person with diabetes, examine their feet. Thereafter, those identified with risk factors should receive simple education on how to look after and preserve their feet.

### ✉ Andrew Boulton

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# Counting the costs

## of the *diabetic foot*

✎ Jan Apelqvist and Gunnel Ragnarson Tennvall

*Diabetes is a chronic condition that requires a life-long commitment of resources to the prevention and treatment of complications. The condition affects an increasing number of people all around the world, putting them at risk for foot ulcers and amputations. In addition to causing acute suffering, foot lesions in people with diabetes have substantial economic consequences: up to 20% of total expenditure on diabetes might be attributable to the diabetic foot. Jan Apelqvist and Gunnel Ragnarson Tennvall report on the economic impact of diabetes foot damage and examine the cost-effectiveness of prevention and the recommended multidisciplinary response to the condition.*



### Direct costs

However, no data are included in these figures regarding follow-up treatment and consequences for people after undergoing an amputation. Only the estimated direct medical cost of the treatment of diabetes foot complications were contemplated. These direct costs are related to inpatient or outpatient care, the use of resources such as surgery, clinical investigations, antibacterial drugs and other medication, dressing material, the treatment of damaged skin (topical treatment), and orthopaedic appliances. Diabetic foot-related costs may rise due to the need for home care and social-service support for people with a disability, transportation to and from a clinic, and home care (by a nurse) to dress wounds.

### Indirect costs

Foot ulcers also have considerable indirect costs. These are defined as the value of lost productivity when people are unable to work or when they die prematurely as a result of the damage to their feet or associated complications. The loss of quality of life should also be calculated into the cost of the diabetic foot.

### Where are the costs?

The cost of diabetes foot damage is influenced by a number of factors,<sup>1</sup> including:

- interventions to prevent foot ulcers
- strategies to heal these ulcers and shorten the time required for healing
- management to prevent amputations in people who have developed ulcers

- care required by people with diabetes with a disability following an amputation.

In 2001, diabetes-related foot ulcers and amputations were estimated to cost US health-care payers 11 billion USD.<sup>2</sup> Corresponding data from the UK estimated the total annual cost of diabetes-related foot complications at 456 million USD.<sup>3</sup>

### Some important foot notes

- 85% of diabetes-related amputations are preceded by a foot ulcer
- 50% to 70% of all lower-extremity amputations are related to diabetes
- 3% to 8% of people with diabetes have a foot ulcer
- The recurrence rate of new ulcers through five-year follow-up is 50% to 70%
- It takes on average 11 to 14 weeks for a diabetes foot ulcer to heal
- There is a 15% amputation rate in people with a diabetic foot ulcer



### Management and treatment

In studies involving people with diabetes foot ulcers who did not require amputation, the treatment costs ranged from 1000 USD to 17 500 USD (in 1998 prices).<sup>4</sup> When discussing the cost of treating diabetes foot ulcers, it is important to clarify the proportions of the overall cost that are incurred in the different aspects of therapy. In a study that followed the treatment until healing of people with diabetes foot ulcers, inpatient care and topical treatment of wounds were in the short term the most expensive item of total cost – whether the person’s damaged feet were successfully healed, remaining intact, or after amputation.<sup>5</sup> The cost of antimicrobial drugs, outpatient visits and orthopaedic appliances were low in relation to total cost.

#### Lower-extremity amputation

In data published between 1994

and 2000, the estimated cost of an amputation was between 16 500 USD and 66 200 USD (in 1998 prices).<sup>4</sup> The cost to society of amputations was high due to the need for prolonged hospitalization, rehabilitation and home care, and social services for the people with a resulting disability. More than 70% of the economic cost of the diabetic foot is incurred after amputation.

#### Long-term perspective

In evaluating the use of resources in the management of diabetes foot ulcers, a long-term analysis should be made. This should take into account the risk of renewed ulceration and amputation, as well as the use of resources resulting from the complications and disability that were provoked by previous ulcers.

A study in Sweden followed people with diabetes and a previous foot ulcer. This concluded that the highest costs

were for inpatient care, social-service support and home care, especially for people with a previous major amputation (above the ankle). The approximate costs (in 1990 prices) during three years from healing were:

- 16 500 USD for people whose wounds were healed without severely impaired circulation (ischemia)
- 27 000 USD for those with ischemia
- 44 000 USD for people who had to undergo a minor amputation
- 63 000 USD for those who had to undergo a major amputation.<sup>6</sup>

#### The cost-effectiveness of prevention

In a model-based cost-utility analysis, it was suggested that if intensive prevention could reduce foot ulcers and amputations by 25%, this would be cost-effective or cost-saving in all people with diabetes – except in those with no specific risk factor other than

diabetes itself.<sup>7</sup> The study was based on a model simulation comparing current prevention of foot ulcers in people with diabetes and other risk factors with optimal prevention – including therapeutic health education, foot care, and appropriate footwear involving management by a multidisciplinary team.

The results of this study indicate that the provision of adequate preventive care to all people who are at risk or high risk of developing diabetes foot ulcers would be highly cost-effective. These include people in the following subgroups:

- people with sensory nerve damage (neuropathy) only
- those with sensory neuropathy and disorders in the blood vessels that supply the legs and feet (peripheral vascular disease) and/or a foot deformity
- people with previous foot ulcers or a previous amputation.

However, it was found that in people who have no risk factor other than diabetes itself, additional preventive measures to avoid foot ulcers or amputation would not be cost-effective.

**Investment in intensive preventive care would be cost-effective or even cost-saving.**

These findings were confirmed in two other European studies, which assert that management of the diabetic foot according to current guidelines for intensive multidisciplinary preventive care would result in improved rates of

survival and a reduction in the number of diabetes foot complications.<sup>8,9</sup> In addition, if reductions in the incidence of ulcers and amputation of 25% to 40% were achieved, this would be cost-effective or even cost-saving compared to current standard care.

### Conclusion

Research into the cost of diabetes foot ulcers and amputations indicate a huge drain on economic resources for both society and individuals. We should conclude from these studies that in any evaluation of the cost of diabetes foot damage, it would be wrong to focus solely on the unit cost for wound-dressing, single products or management procedures. We should take a broader view, encompassing the total use of resources as well as the influence of the health-care system and factors such as reimbursement to the individual. Quality of life should be factored in together with the final clinical outcome and the different management strategies under consideration.

Initiatives to identify the people with diabetes who are at risk of developing foot ulcers and take appropriate preventive measures would be cost-effective or even cost-saving. Investing resources in these would lead to a reduction in the number of people with ulcers or requiring amputation, and thereby reduce the total cost to society of the diabetic foot. The reduction of these costs and improvements in diabetes management and quality of life of people with diabetes require investment in both prevention and the multidisciplinary management of foot ulcers.

### ✉ Jan Apelqvist and Gunnel Ragnarson Tennvall

Jan Apelqvist is Associate Professor for diabetes and endocrinology at the Department of Internal Medicine and Endocrinology Malmö University Hospital and Lund University, Sweden.

Gunnel Ragnarson Tennvall is Research Director and a health economist at the Swedish Institute for Health Economics, Lund, Sweden.

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# The *psycho-social* impact of diabetes *foot damage*

✎ Loretta Vileikyte

*Over half of all lower-extremity amputations are related to diabetes. Indeed, foot ulceration is an increasing problem worldwide and there is little evidence of a reduction in the numbers of foot ulcers and amputations in people with diabetes. In this article, Loretta Vileikyte argues that in order to alleviate the suffering of people affected by this common and disabling complication of diabetes, we must improve our understanding of the psycho-social factors involved in the development of diabetes foot ulcers; and of the ways in which people's day-to-day functioning and their quality of life are influenced by foot damage.*

One of the characteristic features of diabetes foot ulcers, distinguishing them from other chronic wounds, is that they are usually painless – the result of diabetes-provoked nerve damage to the legs and feet (peripheral neuropathy). This loss of the sensation of pain in response to injury has a profound effect on psycho-social outcomes, including non-adherence to preventive self care.

The results of a large UK and US prospective study indicate that the majority of people who are diagnosed with diabetes neuropathy believe that

the development of a foot ulcer will be accompanied by pain.<sup>1</sup> Furthermore, they anticipate that the foot damage from diabetes will be vascular and that this vascular damage will be reflected in poor circulation and 'cold feet'.

These 'folk' beliefs falsely reassure people that their feet are healthy. This in turn leads to a failure to engage in preventive self care and results in the kind of behaviour that is appropriate to people with normal, integral sensations in their feet – such as relying on feeling the fit of shoes when buying a new pair, rather than having feet measured.

In contrast, higher levels of preventive self care are reported by people who are able to accurately interpret their health-care provider's diagnosis of neuropathy and realize that it is possible to have a serious medical condition even if their feet are warm and apparently without symptoms. These findings strongly suggest that the ability of the health-care provider to identify people's misconceptions and correct them – by communicating clear messages about the nature of diabetes foot complications – is pivotal for ensuring effective self care.

**The ability to describe neuropathy clearly is pivotal for ensuring effective self care.**

The loss of the sensation of pain results in a lack of adherence to recommended treatment for foot ulcers – such as wearing a foot ulcer-offloading device to reduce mechanical stress – and contributes significantly to the slow healing or non-healing of foot ulcers.<sup>2</sup> While people with non-neuropathic foot damage avoid walking on such wounds because of the pain this produces, those with insensitive feet continue to walk on



Understanding and empathy might lead to fewer foot ulcers in people who are at high risk.

ulceration on people's physical and psycho-social functioning: when compared with the people whose foot had healed without the need for amputation or indeed those who had undergone a minor amputation, the people with current foot ulcers had lower health status.<sup>3</sup>

These studies used questionnaires that were not specific to foot ulceration; the content was imposed by the investigators. It is therefore possible that their findings left a gap between foot ulceration as abstractly defined, and the reality of a person's experience of living with foot ulcers. In order to develop effective interventions, it is essential to have an understanding of the uniquely personal experience that is quality of life. This reflects the way in which people perceive and react to their health status.

Several questionnaires were recently developed that assess quality of life from the perspective of people affected by foot ulcers. Examples include the Diabetic Foot Ulcer Scale and the Neuropathy and Foot Ulcer-specific Quality of Life Instrument.<sup>5,6</sup> A series of interviews were conducted with people with foot ulcers and their health-care providers in order to elicit the aspects of living with foot ulcers that are important to a person's quality of life.

foot ulcers. This, in turn, prolongs people's physical and psycho-social dysfunction, which often includes restrictions in normal daily activities and associated emotional distress.<sup>3</sup>

### Effects on quality of life

In research into the effects of foot ulceration on people's physical and psycho-social functioning and well-being, it has been found that foot ulcers can be a source of severe disability which, in turn, has a negative impact on quality of life. One study, for example, compared the psychological

status of people with chronic diabetes foot ulcers, those with lower-limb amputations, and people with diabetes with no history of foot ulceration.<sup>4</sup> It was reported that people with chronic foot ulcers and those with amputations made significantly poorer psycho-social adjustments to their situations in their domestic and social environment, and reported poorer overall quality of life, compared to the people with no foot damage.

A study from Sweden further highlighted the impact of foot

These interviews demonstrated that the loss of mobility caused by non-weight-bearing treatment (using a cast, wheel-chair or crutches, for example) is central to the foot ulcer experience. It results in severe restrictions in the activities of daily living, including house work, leisure activities and employment. In one study it was reported that approximately half of the people interviewed had either retired early or lost time from work; and career opportunities were sometimes missed.<sup>7</sup>

Moreover, limited mobility causes problems with social and interpersonal relationships. People commonly suffer perceptions of diminished self-worth due to an inability to perform social and family roles. Changes in a person's social self-perception (the 'self' being perceived as a family burden), in turn, leads to reduced quality of life.<sup>6</sup>

### Depression

While foot ulcer-specific emotional responses are prominent and include fear of potential consequences and anger at health-care providers – stemming from a perceived lack of timely and clear explanations of the nature of foot complications – no evidence for an association between foot ulceration and depression has been found.<sup>8</sup> This finding is somewhat unexpected in view of the evidence that foot ulcers are associated with severe restrictions in mobility, loss of work time, and other disruptions in activities of daily living.

A possible explanation as to why foot ulcers are not associated with depression could be that the level of physical disruption caused by foot

ulceration does not reach those required to diagnose depression. It is also possible that people affected by foot ulcers receive sufficient social (family and medical) support, which may act as a buffer against depression.

However, it is important to remember that although foot ulceration is not associated with depressive symptoms, other experiences of neuropathy, such as pain and unsteadiness, are important predictors of depression in this group of people. Therefore, people with diabetes nerve damage have an increased risk for depressive symptoms. They should be carefully monitored to determine whether they are depressed and provided with treatment or referral as necessary.

**People with neuropathy should be monitored for depressive symptoms.**

### Conclusion

In summary, diabetes foot ulcers are a source of severe physical dysfunction, emotional distress and poor quality of life. People often respond to diabetes foot complications by creating their own models or understanding about this condition, which are inconsistent with their health-care professional's biomedical view, and result in a lack of foot self care. The health-care provider's ability to understand and empathize with their patients' common-sense perspective is therefore central to effective communication. This might potentially lead to fewer foot ulcers and better physical and psychosocial functioning of people who are at high risk for diabetes foot damage.

### ✉ Loretta Vileikyte

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## Religion, politics and the diabetic foot in Senegal

✉ **Maïmouna Ndour Mbaye**

People in Senegal come from a wide variety of ethnic groups; about three-quarters of the population live in rural areas. While a number of faiths and cultures are recognized in Senegal, Islam is the predominant religion: over 90% of the people in Senegal are Muslim. Islamic communities here are often organized around one of several orders or brotherhoods, headed by a *khalif*. Indeed, the systems outside the State have a powerful influence in Senegalese life and politics.

Sixty seven-year-old Venerable Karamogo is the spiritual and community leader of a village in the South of Senegal. About nine years after Karamogo was diagnosed with diabetes, a chronic infection developed in his left leg. The surgeons recommended amputation; but this advice was firmly rejected by Karamogo and his family. Apart from the common and understandable fear of losing a limb, Karamogo and his family expressed their strong concerns over two main issues – one religious, the other political.

There is a verse in the Koran which states that “no modification of God’s creation” shall be performed. The strength of Karamogo’s belief was such that he preferred an early death with his body intact to a longer life without one of his legs.

The second issue was culturally based and had the potential to provoke political consequences. Traditionally in Senegal, it was understood that a leader who had been injured during combat or had a handicap could not govern. Although Senegal has a democratic political culture, it has a history of kingdoms, brotherhoods and colonial struggles. An injury such as the loss of a limb continues to be regarded as a weakness and has been the reported motivation behind uprisings in Senegal even against royalty. It is understandable then – while not ceasing to be reprehensible – that Karamogo’s wound remained hidden for weeks before his first consultation.

Seen in this context, it is also easier to understand the stance of Karamogo’s family. Fears for the physical well-being of a father or grandfather were countered by concerns about the wider impact in their community of a surgical intervention.

A series of discussions ensued between health providers and Karamogo and his family. As a result, the operation to amputate the infected leg was postponed, and a nurse was called in to tend to the wounds. The ulcers on Karamogo’s leg were debrided correctly and the dressings changed daily. This treatment lasted several months and had a spectacular outcome: the leg healed.

This ‘happy ending’ concludes for the moment the story of Venerable Karamogo and his diabetes foot complications. It is a story that we use at the University in Dakar to illustrate the impact on our daily practice of the social, cultural and religious factors that are particular to this country. Like all good stories, this one draws the listeners into a person’s life and helps them to understand the choices that the person made. It is my hope that when you read this story, wherever you are, it serves as a reminder that, as health-care providers, it is imperative that we appreciate people’s culturally based sensitivities, however bizarre these may at first appear to us.

For those of us who are physicians working with people with diabetes, there is another important message: a nurse who saves one leg is of more value to a person with diabetes foot complications than a surgeon who amputates ten!

✉ **Maïmouna Ndour Mbaye**

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# Diabetes foot damage

in developing countries:

*the urgent need for education*

✉ Zulfiqarali Abbas and Stephan Morbach

*Figures released by the International Diabetes Federation suggest that worldwide in 2003 there were almost 200 million people with diabetes – a global prevalence of 5.1%. The report predicted that over the coming decade, the greatest increases in the numbers of people with the condition will occur in Africa and Asia, provoking hugely increased rates of death and disability. Diabetes foot complications constitute a major public health problem, particularly for people with diabetes in developing countries. In this article, Zulfiqarali Abbas and Stephan Morbach look at the factors that are specific to developing regions, which compound the damage caused by the diabetic foot.*

## Poverty meets low priority

Peripheral neuropathy is the principal underlying risk factor for foot ulcers in people with diabetes (see the article by Vilma Urbančič-Rovan in this issue). In one study it was noted that 100% of the people with foot ulcers who attended a clinic in Dar es Salaam, Tanzania had peripheral neuropathy.<sup>3</sup> A more recent study of the clinical outcome of people with foot ulcers in that city found that 15% of people with the condition admitted to Muhimbili National Hospital had foot ulcers; 80% of these were first-time occurrences.<sup>3</sup>

Depressingly, the data from this study showed that amputation is a frequent outcome (33%) in people with diabetes foot ulcers.<sup>3</sup> The highest in-hospital mortality rate (50%) was seen among people with severe foot ulcers whose inpatient management did not include surgery with amputation. Similar findings have been recorded in other parts of Africa, such as Burkina Faso (38%), Ethiopia (53%) and Kenya (55%).<sup>1,3</sup>

People with peripheral neuropathy feel no pain in their damaged feet and are thus at high risk of severely injuring themselves without even realizing it. Living in a low-income setting increases this risk. It was reported that 25% of people with diabetes attending

a large clinic in Tanzania showed varying degrees of symptoms or signs of peripheral neuropathy.<sup>1,2</sup> Other studies across Africa have documented a wide range in the occurrence of peripheral neuropathy, from 4% in Zimbabwe to 84% in Algeria.<sup>1</sup>



In many regions, foot problems receive less attention than other diabetes complications.

In the south-east Asian region, diabetes foot care remains a low priority; foot problems do not receive the same level of attention as other diabetes complications. As a result, for example, in India, almost 40 000 legs are amputated every year as a consequence of diabetes. As in the African countries, the most common cause of amputations in this region is an infected neuropathic foot, which could potentially be prevented.

**In India, almost 40 000 legs are amputated every year as a consequence of diabetes.**

Unhygienic conditions and poverty compound the effects of foot ulceration in people with diabetes foot complications in developing countries. Other major factors that contribute to the development of ulcers include walking barefoot or delays in reporting to a medical centre for clinical assessment. It should be remembered that for people with diabetes who live on or below the poverty line, buying appropriate footwear might not be feasible or of high priority.

In rural areas, people with peripheral neuropathy often inadvertently sustain foot injuries while walking barefoot at night. Furthermore, people who habitually sleep on the floor or outdoors are at risk of suffering rodent bites on their toes. For people with diabetes with peripheral neuropathy, such injuries might go unnoticed until the person has an ulcer or injury that has progressed to chronic foot sepsis.

The lack of pain that is characteristic of peripheral neuropathy may cause ordinarily conscientious, responsible people to be unaware that, by using inappropriate or ill-fitting footwear, walking barefoot, or using chemical agents or razor blades on calluses or to cut toenails, they are sustaining injuries. Those most at risk of developing infected foot ulcers are the people who do not have sufficient information, skills or motivation to care for their feet or are unable – often because of the difficulty and expense of travel – to attend a diabetes outpatient clinic for follow-up care, advice, or education.

#### *Infection*

It is not surprising that foot infections are especially common in people who live in areas where there are no available podiatry services. (For an overview of global podiatry services, see the article by Andrew Boulton in this special issue.) People in developing countries often go to hospital only after the onset of gangrene or when the sepsis in their foot might be intractable to conventional supportive treatment with antimicrobials, intravenous fluids and insulin.

A lack of training in diabetes foot lesions leads to the unfortunate practice, still carried out, of soaking a person's diabetic foot in water. Often, the damage is ignored or detected relatively late in the course of the infection after unsuccessful home or herbal therapy. For cultural reasons many people first contact their local traditional doctor; it may also be the case that the nearest diabetes clinic is more than a day's journey away.

#### **Conclusion**

Education remains the most powerful preventive tool in underdeveloped countries, and should form an integral part of prevention programmes. This should be simple, repetitive and culturally appropriate. Cost-effective education should be targeted at both health carers and people with diabetes. A comprehensive foot-care programme should include therapeutic health education, regular foot examinations, and screening to identify those at high risk. Appropriate footwear should be encouraged, as well as the maintenance of good blood glucose control and educational programmes promoted for health-care providers as well as people with diabetes.

#### ✉ **Zulfiqarali Abbas and Stephan Morbach**

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*Stephan Morbach is a consultant physician at the Diabetic Clinic, Department of Internal Medicine, Marienkrankenhaus, Germany. He is Chairperson of the Diabetic Foot Study Group of the European Association for the Study of Diabetes.*

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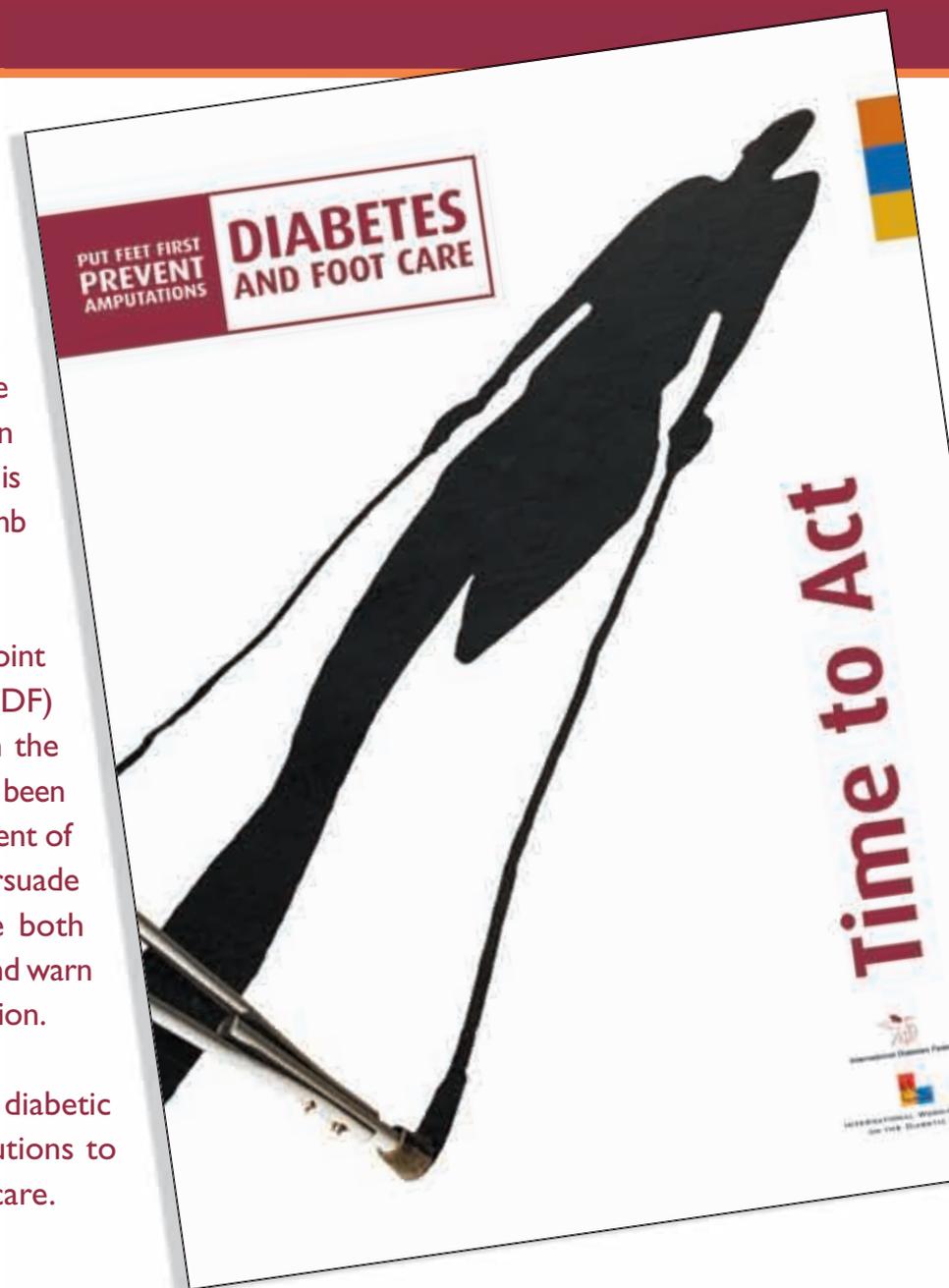
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# Diabetes and foot care: Time to act

Although people with diabetes are at risk from a number of chronic complications, such as kidney failure and eye damage, complications of the foot represent the greatest burden in terms of human and economic costs. It is estimated that up to 70% of all lower-limb amputations are related to diabetes.

*Diabetes and Foot Care: Time to Act*, a joint International Diabetes Federation (IDF) and International Working Group on the Diabetic Foot (IWGDF) publication, has been produced to inform people of the extent of diabetic foot problems worldwide, persuade them that preventive measures are both possible, affordable and cost effective, and warn of the consequences of not taking action.

Written by international experts in diabetic foot care, the publication offers solutions to those working to improve diabetes care.



*Diabetes and Foot Care: Time to Act* is available in English and can be ordered at a special pre-launch price by completing the form on page 48 or by visiting the IDF bookshop at [www.idf.org/bookshop](http://www.idf.org/bookshop).

# Understanding the development of diabetic foot complications

✎ Vilma Urbančič-Rovan

*Foot complications are the leading cause of hospitalization in people with diabetes. Losing a limb is one of the most dreaded complications of the condition – with reason: compared to those without the condition, people with diabetes have a 15-fold increased risk of suffering an amputation. In this article, Vilma Urbančič-Rovan describes the pathophysiology of diabetes foot damage and argues that the amputation rate could be significantly reduced with improved care and education for people with the condition.*

The cascade of events that can ultimately result in gangrene and amputation most often begins with a foot ulcer. About 15% of people with diabetes have a foot ulcer at some point in their life. The major risk factors for foot ulceration are: nerve damage (neuropathy) and impaired blood supply in combination with deformities of the feet and the resulting increased pressures on areas of the sole.

Other contributing factors include:

- a history of previous foot ulcers
- inadequate footwear
- a lack of (or low-quality) podiatry care
- poor diabetes management

- psychological factors
- tobacco smoking
- old age
- low social status.

An infection can complicate any ulcer but is seldom the sole reason for gangrene and amputation.

**About 15% of people with diabetes have a foot ulcer at some point in their life.**

### Sensory neuropathy

Diabetes neuropathy is a complication of long-standing diabetes. It is strongly related to the control of a person's

average blood glucose levels and affects the entire nervous system. Sensory neuropathy leads to an impaired ability to feel pain, temperature or touch. A person's affected foot is insensitive to noxious stimuli such as shoes that are too tight, water that is too hot, and foreign bodies (stones or pins, for example) in the shoes. People with this sensory deficit frequently also suffer accompanying burning pains and cramps, particularly at night.

### Motor neuropathy

Motor neuropathy provokes the wasting or loss (atrophy) of muscle tissue and deformities in the feet. The typical changes are known as 'claw toes' or 'hammer toes'. A foot deformity leads to the redistribution of the areas of the foot which sustain most pressure during standing and walking. This in turn gives rise to the formation of hard thick skin (callus) on pressure points, which sooner or later results in ulceration.

Much harm can be caused by cures for hard skin. These medications are applied to corns in order to soften them and make their removal easier. If a person has an insensitive foot, however, these agents can penetrate



very deep into the tissue without causing any pain. The resulting chemical ulcers are very resistant to treatment.

**Chemical ulcers resulting from cures for hard skin are very resistant to treatment.**

#### *Autonomic neuropathy*

The autonomic nervous system supplies nerves to all organs and organ systems in the human body. When the branches which innervate people's sweat glands are affected, they sweat less or even not at all. While this might seem like a benefit – feet do not smell and socks can be worn more than once – it is not.

The skin is dry and highly prone to cracks and fissures which allow entry to pathogenic micro-organisms. Autonomic neuropathy also affects blood flow to the skin by provoking structural changes of the capillaries.

#### *Charcot foot*

Associated with neuropathy, Charcot foot (neuro-osteoarthropathy) is a severe limb-threatening condition involving the destruction of bone and joints. Charcot foot is often overlooked in its early stages and is sometimes mistaken for infection. In the final stage, the foot architecture is completely lost, the foot resembles 'a bag of bones' and is highly prone to ulceration. (Andrew Clarke in this

Peripheral vascular disease is two- to three-times more prevalent in people with diabetes.

issue describes the non-infectious diabetes-related transformations of the surface and structure of the foot that often result in ulceration, including Charcot foot.)

#### *Peripheral vascular disease*

Lower-extremity peripheral vascular disease results from a build-up of atherosclerotic plaque in the blood vessels that supply the feet and legs. In people with diabetes, peripheral vascular disease is two- to three-

times more prevalent than in people without the condition. The most frequently affected arteries are those below the knee; in smokers with diabetes, the atherosclerotic lesions can develop above the knee. The atherosclerotic narrowing of a person's arteries reduces the blood flow, making this insufficient to cover the tissues' needs for oxygen.

**In smokers, atherosclerotic lesions can develop above the knee.**

Although large interventional studies have not demonstrated a significant impact of improved metabolic control on the progression of peripheral vascular disease, a favourable influence of intensive insulin treatment on coronary and carotid arteries in people with type 1 diabetes has been shown recently.

Other risk factors also play a role in the development of this condition. These include:

- abnormally high levels of blood fat
- high blood pressure
- a sedentary lifestyle
- obesity
- tobacco smoking
- a hereditary predisposition.

#### Foot ulcers

Foot ulcers often develop as the result of a lesion which might go unnoticed in people with diabetes sensory neuropathy. As well as the previously mentioned scalds from washing with hot water and blisters from improper footwear, burns sustained by walking barefoot are common in people in

developing countries. Going barefoot to the toilet at night is a high-risk habit, especially if a person has poor eye-sight. (The factors relating to the diabetic foot which are specific to people in developing countries are discussed in this issue by Zulfiqarali Abbas and Stephan Morbach.)

It is important to realize that foot lesions can develop even in people with properly fitting footwear after sustained periods of walking or trekking. A further note of caution: harm can be caused by podiatrists and pedicurists who are unaware of the potential hazards.

An ulcerated foot is highly prone to infection. Local (pain, swelling, redness, discharge from the wound) and systemic signs of inflammation (fever, malaise) are often reduced in people with diabetes. For these reasons, diabetes foot infections are easily overlooked and often people seek help when their foot, affected by advanced gangrene, is already impossible to save.

**Regular examinations, structured education and emotional support are vital.**

#### Prevention through education

The role of psychological factors has been explored extensively in the last decade. It has been demonstrated that these are as important for the development and outcome of diabetes foot ulcers as physical factors.

People with diabetes, regardless of their socio-economic status or their level of education, share a common

fear of limb loss and a decreased ability to recognize the early warning signs of a limb-threatening condition.

Besides regular foot examinations at home and in the health-care setting, structured foot-care education and emotional support therefore represent the most important measures towards a reduction in the number of diabetes-related amputations.

#### ☒ Vilma Urbančič-Rovan

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#### Further reading

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# Cause for concern: the pathology of the non-ulcerative foot

✉ Andrew Clarke

*Those people with diabetes who are aware of the threat that is posed by diabetes foot complications are right to be terrified by the worst-case scenario: the loss by amputation of one of their feet or legs. People with diabetes are at risk of developing a series of common conditions that can represent a conduit for infection to their vulnerable feet. Andrew Clarke describes the apparently minor conditions that in fact require adequate attention or need to be prevented before chronic ulcers develop and the consequences become tragic.*

In its consensus document, the International Working Group on the Diabetic Foot states: “There is no such thing as a trivial lesion of the diabetic foot.” Corns and calluses, blisters, dry cracked skin, thickened or ingrown nails, fungal infections of the nails or skin, or foot deformities such as flat feet or bunions, are all cause for concern to people with diabetes. Furthermore, many people with diabetes also have other medical conditions, such as arthritis.

## Charcot foot

Probably the most serious non-ulcerative foot condition is called Charcot foot. Charcot foot is associated with diabetes nerve damage (neuropathy), and results in the foot changing shape – the non-infectious destruction of bones and joints. This condition affects people who have lost their sense of pain – the sense that protects a person’s feet from being pushed beyond their limits when walking, standing or exercising.

For health professionals, acute Charcot foot is difficult to detect; because the foot has an area of redness and swelling, it is often treated as an infection. The feet of people who have had a previous minor amputation are at increased risk for Charcot foot. The acute Charcot foot is usually painless and may be mistaken for cellulitis. If the condition continues to go unrecognized or is not properly managed, Charcot foot can have disastrous consequences, including amputation.

**Charcot foot is difficult to detect; it is often treated as an infection.**

Despite the difficulties in diagnosing this condition – in an initial x-ray the foot may appear normal – immediate detection and immobilization of the foot is essential. A life-long programme of diabetes foot education, protective footwear and routine foot care are required to prevent ulceration. A person might be alerted to



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Charcot foot if they have a history of injuries such as tripping or falling.

### Skin and subcutaneous tissues

#### Corns and calluses

Callus and corns are defined as:

- Callus – an area of thickened skin
- Corn – an area of callus moulded into a nucleus by concentration of stresses.

The thickening of the skin represents the normal physiological response of people's feet to pressure and friction. Corns and calluses, while generally not harmful, can lead to infection and ideally should be removed regularly by a podiatrist or health-care professional who is skilled in the technique of 'sharp debridement' (for a description of this technique, see

the article by Stephanie Wu and David Armstrong in this special issue).

The usual cycle of events that leads to the hardening and thickening of the skin begins with intermittent compression and release. This causes the skin cells to become inflamed and overactive. These cells seem to stick to each other, reducing the rate at which the body sheds dead skin.

**An ulcer may be imminent or already present underneath a callus.**

These apparently minor lesions should never be underestimated. They can lead to an ulcer and provide an entry point for infection to spread. The feet of

*"There is no such thing as a trivial lesion of the diabetic foot."*

people with diabetes should be inspected for the presence of callus and corns. These may change colour, develop with cracks, and blistering. Special attention should be paid to those areas of callus formation in which some bleeding may have occurred: an ulcer may be imminent or already present underneath the callus.

#### Dry skin

This can be the result of aging, but is usually associated with nerve damage (neuropathy), which reduces the body's sweating mechanism.

### Cracked skin

Fissures or cracks in the skin occur in two main sites: around the heel and between the toes. Both indicate the skin's inability to cope with local stresses. The skin at the heels is usually dry; between the toes it is moist.

### Warts

Warts are caused by a virus – one of the 'papova' group of viruses. These provoke benign, spontaneously regressing tumours in the skin, which may require treatment.

### Fungal infections (Athlete's foot)

Fungal infections are provoked by yeasts and moulds that infect the skin between and underneath the toes and on the soles of the feet. Fungal spores are found in many different environments, including communal showers, sandy beaches, carpets and mats, animals, and soil.

The condition develops when skin scales become infected with elements called 'hyphae'. These can remain dormant until suitable growing conditions arise. Between the toes, moist cracks occur; on the soles, small, itchy blisters develop. Athlete's foot (also known as tinea pedis) may also occur on the sole as inflamed, thickened, dry scaly skin.

**It is essential for people with diabetes to be aware of the status of their foot risk.**

### Disorders of the nails

Damage to the growth matrix of a toenail causes the thickening, or deformed thickening, of the toenail

itself. This causes pain, discomfort and sometimes impedes mobility. Abnormal curvature of a nail is usually not painful until discomfort is caused by an external factor such as pressure from shoes or poor self-treatment.

Fungi and yeasts can also infect the toenails. The infecting organism usually begins at the front of the nail and slowly softens the nail, leaving yellow/brown streaks and possibly an odour.

### Ingrown nail

This is caused when a shoulder or splinter of nail pierces the skin at the edge of a nail. As the nail continues to grow, tissue forms which normally heals lesions. However, this is unable to bring about healing because the piece of nail remains inside the skin. This causes hyper-granulation or 'proud flesh'.

**The foot is an amazing structure - and few are perfect.**

### The connective tissues

The foot is an amazing structure of bones, joints, ligaments and muscles, all of which are designed to work in harmony. Few people have perfect feet; we rely on being free of pain and deformity as the measure of the structural health of our feet. There are certain foot structures that need special mention because they reflect alterations in the alignment and therefore function of the feet. These changes usually place an increased load on another part of the foot.

Highly arched or low-arched feet can both cause pain and increased

pressures on the feet, especially the soles. Deformities such as bunions are also evidence of an unbalanced foot structure and lead to increased local pressures, causing callus or corns.

### Conclusion

It is essential for people with diabetes to have their feet examined regularly and be aware of the status of their foot risk. Neuropathy is painless; poor circulation causes skin to be unable to withstand normal day-to-day stresses and strains. Keeping good foot health reduces the risk of ulcers and amputation.

### ✉ Andrew Clarke

Andrew Clarke is a podiatrist in private practice at the Wits University Donald Gordon Medical Centre, Johannesburg, South Africa and works at the Chris Hani Baragwanath Hospital diabetes and arthritis clinics, in Soweto, South Africa.

# Screening for the diabetic foot:

## how and why

✎ Edgar Peters

*Given the dimensions of the current global diabetes pandemic, the number of people who are at risk of developing a diabetes-related foot complication is enormous – and growing. Everybody with the condition is at risk, irrespective of the type or severity of their diabetes. The aim of screening is to identify the people who are at greatest risk in order to allocate to them limited medical resources. Several simple screening techniques exist that can help to distribute therapeutic and preventive foot care to those in greatest need. Edgar Peters reports.*

Nerve damage is common in people with diabetes, affecting up to 50% of people with the condition. When the pain and temperature sensations that normally protect our feet from injury are reduced or lost, people's feet may be injured without them being aware of a problem. (For more on diabetes neuropathy, see the articles by Andrew Boulton and Vilma Urbančič-Rovan in this special issue).

### *Nerve damage*

A number of methods have been developed to test for impaired sensation. The best documented of these is with a nylon 'Semmes-Weinstein monofilament' (see figure page 26). This applies 10 g of force on the skin. If this pressure is not perceived on one or more defined areas of the foot, the person is considered to have diminished sensation.

Another instrument, a 'biothesiometer', is used to test the perception of vibrations in the first (big) toe. Alternatively, this can be done using a tuning fork, which is cheaper than a biothesiometer but less reliable.

**Infections are less likely to heal in people with poor blood supply.**

### *Vascular disease*

If people have poor blood supply to their feet (peripheral vascular disease) – also common in people with diabetes – wounds and infections are less likely to heal: the availability of nutrients and oxygen is reduced and protective immune cells are not able to reach the tissue of the foot. In some cases of poor blood supply, ulcers develop even in the absence of nerve damage. Techniques to screen people with diminished blood supply involve identifying pulsating blood vessels in the foot and measuring blood pressure in these vessels.

All of the risk factors mentioned above are usually present in people who have suffered previous ulcers or amputations. Indeed, scar tissue and healed minor amputations are deformities in their own right, and can lead to alterations in the distribution of pressure on the soles of the feet when walking or standing. It is not surprising that people with previous amputations are at highest risk of developing further diabetic foot complications.

### Classifying the risk

The International Working Group on the Diabetic Foot has developed a system for the classification of risk that can predict which people with diabetes are at risk for diabetes foot problems. People can be graded using readily available and relatively inexpensive instruments. This classification (see table) consists of four risk groups ranging from a low-risk group of people without risk factors to those with a previous ulcer.<sup>1</sup>

*Figure: Application of the Semmes Weinstein monofilament*



*The monofilament is buckled on the skin for one second and then released in all of the three designated areas. If one or more applications are not felt, the foot is considered to have diminished sensation.<sup>1</sup>*

People with previous ulceration are in fact 34-times more likely to develop a new ulcer over three years than those without any risk factors. Over the same three-year period, people who have endured a previous amputation are 100-times more likely to develop a foot ulcer compared to those without any risk factors.<sup>2</sup>

**People with a previous amputation are 100-times more likely to develop a foot ulcer.**

### Prevention

It has been demonstrated in settings in North America, Europe and India that aggressive management of diabetes foot complications can prevent ulcers and subsequent amputations. Reductions in the number of amputations range from 48% to 79%. As a result of these preventive programmes, not only does the number of amputations decrease,

reductions have been reported in hospitalizations, emergency-room visits, antibiotic prescriptions, foot operations and missed working days.

**Optimal control of blood glucose is crucial in preventing foot problems.**

A reduction in health-care consumption leads to reductions in the overall cost of health care.

A Swedish study calculated that the total direct cost of an amputation was between 16 500 USD and 66 000 USD, while the direct cost of healing infected foot ulcers was between 1000 USD and 17 500 USD. It was calculated that intensive foot-management programmes are cost-effective when more than 25% of foot ulcers are prevented. (For more on the economics of



Table: Risk-categorization system for diabetes foot complications (International Working Group on the Diabetic Foot)

Category	Risk profile	Check-up frequency
0	Sensation intact	Once a year
1	Diminished sensation Blood supply intact, no foot deformities such as hammer or claw toes	Every six months
2	Diminished sensation Blood supply compromised or foot deformity such as hammer or claw toes	Every three months
3	Previous ulcer or amputation	Every one-to-three months

diabetes foot complications, see the article by Jan Apelqvist and Gunnel Ragnarson Tennvall in this issue.)

**The focus of prevention should be on foot-care education.**

Different areas of intervention are important in prevention. The strong focus should be on foot-care education for people with diabetes and their family members, and on smoking cessation. As described by Margaret McGill in this special issue, education should include practical instruction on how to:

- inspect feet and shoes
- choose appropriate footwear
- notify a health-care provider immediately if a cut, blister or sore develops.

A study in India suggested that people with diabetes who were able to follow

advice from a health-care provider had a lower rate of foot problems (5%), compared to those who did not adhere to recommendations (25%). Furthermore, regular inspection of people's feet by a health-care professional leads to the early detection of potential foot problems. In order to be effective, these examinations should be followed, where necessary, by referrals to an appropriate specialist.

The removal of dead tissue and callus (debridement) by a surgeon or podiatrist should be performed regularly, especially in people who are at high risk. Importantly, large studies have indicated that optimal control of blood glucose is crucial in preventing foot problems.

**✉ Edgar Peters**

*Edgar Peters is a physician and resident in internal medicine in the Department of Internal Medicine, HagaZiekenhuis, The Hague and Leiden University Medical Centre, the Netherlands.*

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## Multidisciplinary care: saving Mr L's toe

✉ Tazmin Clingan and Thyra Bolton

This is the story of 'Mr L', a man in Australia with type 2 diabetes and severe diabetes nerve damage (peripheral neuropathy). He developed neuropathy-related ulcers on one of his toes, which remained untreated for a number of months. He faced the prospect of having his left foot amputated. However, this was prevented because Mr L was linked to a multidisciplinary hospital-based diabetic foot clinic.

Mr L's story began after the debridement by his local podiatrist of calluses on one of Mr L's toes. The toe became sore and Mr L noticed bleeding. After two weeks, he notified his family doctor who lanced the area and prescribed antibiotics. The family doctor saw him on another six occasions, potentially delaying the multidisciplinary care he required.

When Mr L was informed of the possibility of losing the toe, he said he felt shocked; he had not anticipated this outcome and was unable to envisage living without one of his toes. The toe deteriorated and Mr L was sent to his local hospital. But he was discharged a few hours later; his problem was not considered 'serious'. Fortunately Mr L had a previously arranged appointment with his vascular surgeon – following surgery on his right leg. When the surgeon saw the toe, he admitted Mr L to hospital for intravenous antibiotic therapy.

Mr L was admitted to hospital for six days and given intravenous antibiotics (Ciprofloxacin). The High Risk Foot Clinic was asked to review Mr L on the fifth day. The toe was swollen, hot and red with cellulitis developing on the dorsum of the foot (the side opposite the sole). The prescribed antibiotics were not controlling the infection. The High Risk Foot Team suggested he change medication and receive intravenous Flucloxacillin. The tip of Mr L's toe was heavily callused, which was placing pressure on the underlying tissue. As he had good blood supply, the callus was debrided, wound care advised and a toe prop made to help elevate the toe from any weight-bearing surface. Mr L was given a protective shoe to wear instead of his usual footwear. A follow-up appointment was made at the Diabetes Centre High Risk Foot Clinic for one week after discharge.

Unfortunately, although his toe was reported by the medical team as "still slightly red and swollen", Mr L



received only one dose of Flucloxacillin and was discharged the following day. There was little improvement in the infection when he was seen in the High Risk Foot Clinic. A repeat x-ray revealed bone infection (osteomyelitis).

The Diabetes Centre foot protocol recommends that osteomyelitis be treated for three months. Mr L was seen weekly in the High Risk Foot Clinic for debridement, evaluation of infection and offloading of pressure. Antibiotic therapy and wound-care treatment continued and the ulcer healed after twelve weeks. An x-ray at 14 weeks showed resolution of the osteomyelitis.

Mr L's antibiotic therapy was ceased and he underwent a biomechanical assessment. He was referred for orthoses and shoes to a specialist in therapeutic footwear who visits the High Risk Foot Clinic. He was then discharged to a private podiatrist for ongoing foot management.

Strange though it may seem, leaving the High Risk Foot Clinic is often difficult for people like Mr L who have such an intense weekly follow-up. In fact, Mr L commented as he left the clinic, "I'm really going to miss coming to see you all every week!" As members of a multidisciplinary foot-care team, it is also often hard to say goodbye; the satisfaction comes when we see people healed and getting on with their life. And the best part of this story is that Mr L remains ulcer-free.

✉ Tazmin Clingan and Thyra Bolton

Tazmin Clingan is a podiatrist and Thyra Bolton is a foot nurse at the Diabetes Centre, Royal Prince Alfred Hospital, Sydney, Australia.

# Managing the diabetic foot:

## treatment, wound care and offloading techniques

☒ Stephanie Wu and David Armstrong

*Foot ulcers are caused by an imbalance between excessive pressure on the sole of the foot and repetitive stress from walking. It does not take much pressure to provoke an ulcer, so the skin has a built-in protection system. Normally, harmful pressure or motion against the skin will set off a protective pain alarm. Unfortunately, in people with diabetes nerve damage (neuropathy), this pressure goes undetected and can cause serious injury. Having lost the 'gift of pain', people with diabetes neuropathy often do not notice the problem until an ulcer has formed. Stephanie Wu and David Armstrong provide an update on the latest optimum treatments for people with diabetes foot damage.*

When a person's feet receive an adequate supply of blood, the treatment to heal a diabetes-related foot ulcer is centred on relieving repetitive pressure and managing the area of the foot affected by the ulcer (optimizing the wound environment). Pressure reduction is commonly known as 'offloading'. This is most successful when

force is spread over a wide area using devices such as a total-contact cast.<sup>1</sup> An infection-free wound environment is provided using a technique called debridement. The following section provides instructions for the surgical debridement of diabetes foot ulcers that are not infected and receive an adequate supply of blood.

### Debridement

Any dead tissue should be removed from the wound, as required, using a sharp tissue nipper or scalpel or a curette. Finger pressure may be applied to the wound to help control bleeding. The wound may then be probed to check for underlying tissue and infection. Following adequate debridement, the wound can be dressed and pressure offloaded as required. At follow-up, the absence of undermining of the wound edges is a good sign that the wound has been appropriately offloaded.

**The absence of undermining of the wound edges is a good sign of appropriate offloading.**

### Wound healing

A wound repairs as a result of an orchestra of highly integrated cellular and biochemical responses to an injury. Integrating bio-engineering with advances in our understanding



The close fit of the plaster shoe helps to distribute pressure to the plantar foot as a whole.

of the complex mechanisms of the wound healing process have led to the development of various products, such as new wound dressings, growth factors, negative-pressure wound therapy, and living skin equivalents. Negative-pressure wound therapy is one of the most promising of these.

### *Negative-pressure wound therapy*

Negative-pressure wound therapy is the controlled application of sub-atmospheric pressure to a wound using an electrical pump and specialized wound dressings. Studies have suggested that the effects of applying negative pressure include:

- the optimization of the flow of blood
- the reduction of swelling in local tissue
- the removal of potentially damaging wound fluid.

**Negative-pressure wound therapy stretches cells, which stimulates wound healing.**

These physiological changes give rise to a moist environment for healing and facilitate the removal of bacteria from the ulcer. Additionally, the application of sub-atmospheric pressure may help to increase the rate of cell division and subsequent formation of granulation tissue.

Although the exact effect of negative-pressure wound therapy on wound healing is not clear, it has been suggested that the application of micro-mechanical forces to wounds deforms or stretches individual cells, which

stimulates cell growth and wound healing. This appears to be potentially effective in improving healing in complex diabetes foot lesions.<sup>2</sup>

### **Offloading**

Common methods to offload pressure on the foot include: bed rest, the use of a wheel chair, crutches, total-contact casts, felted foam, half shoes, therapeutic shoes, custom splints, and removable cast walkers.

### *Removable cast walkers*

Removable cast walkers can be taken off to allow self-inspection and treatment of a wound. People can bathe and sleep comfortably, and because they can be taken off, removable cast walkers can be used for infected wounds as well as superficial ulcers. Removable cast walkers limit propulsion by keeping the ankle at an angle of 90° and thereby help to reduce pressure on the sole (plantar surface) of the foot.

The best feature of the removable cast walker is also paradoxically its potential downfall. The ability to remove the device eliminates the element of 'forced adherence' that is the finest attribute of the total-contact cast.

### *Total-contact casting*

Of the numerous offloading devices, total-contact casting is considered by many to be the 'gold standard' in achieving the redistribution of pressure and healing. The use of a plaster cast to treat neuropathic foot lesions has come to be known as total-contact casting because it employs a well-moulded, minimally padded cast that maintains contact with the entire plantar surface

of the foot and the lower leg. The close fit of the cast material to the plantar surface of the foot increases the plantar weight-bearing surface area to help distribute the pressure from one or two distinct areas to the plantar foot as a whole.<sup>3</sup> Most importantly, the total-contact cast is not removable.

**Total-contact casting is considered the 'gold standard' in achieving pressure redistribution.**

Unfortunately, however, there are also a number of potentially negative attributes that may discourage some health-care professionals from using this modality. The application of total-contact casting is time-consuming and often associated with a learning curve. A poorly fitting cast can provoke skin irritation and in some cases ulceration; most medical centres do not have a health-care professional or cast technician available with adequate training or experience to safely apply a total-contact cast. In addition, total-contact casts do not allow assessment of the foot or wound on a daily basis and are therefore often contraindicated in cases of infections in soft tissue or bone.

### *Removable cast walkers*

A similar degree of success in terms of reducing plantar pressure has been seen with some removable cast walkers (walking braces).<sup>4</sup> However, in a study that compared the effectiveness of total-contact casts, removable cast walkers, and half-shoes, this did not translate into equivalent time to healing: when compared with the two

other modalities, a significantly higher proportion of people with diabetes foot ulcers were healed after 12 weeks wearing a total-contact cast.<sup>1</sup>

The reason people do not heal well in removable devices is precisely because they are removable. In the absence of pain, people with diabetes neuropathy generally do what feels best. A heavy boot does not feel like the best option to many people – even when there is an open wound present.

### *Instant total-contact casting*

It would be ideal to be able to take the clinical efficacy of the total-contact cast and combine it with the relative ease of application of the removable cast walker. The instant total-contact cast is an innovative approach which attempts to do just this. The instant total-contact cast involves simply wrapping a removable cast walker with a single layer of cohesive bandage, elastoplast or casting tape. This forces a person to adhere to advice to immobilize their foot – ensuring pressure redistribution – while allowing for ease of application and examination of the ulcer when needed.

Two additional studies were conducted to test the wound-healing efficacy of the instant total-contact cast. The first randomized controlled study compared the standard total-contact cast with an instant total-contact cast.<sup>5</sup> No differences were found in healing rates and average healing time. Furthermore, there were also no differences in complications between the two groups.

However, the cost in materials and personnel was much lower for the

instant total-contact cast. The study concluded that the instant total-contact cast, when compared with the total-contact cast, is not only equally efficient in healing diabetes foot ulcers, it is quicker and easier to use, and more cost-effective.<sup>5</sup>

**The instant total-contact cast is easy to use, and cost-effective.**

A parallel study that compared the effectiveness of a removable cast walker and an instant total-contact cast showed comparable results in the healing of diabetes foot ulcers.<sup>6</sup> The study found that a significantly higher proportion of people healed in the instant total-contact cast group, when compared with those using the removable cast walker; of the people whose healed, those who used the instant total-contact cast healed significantly faster.

### **Conclusion**

There is a high occurrence and recurrence of foot ulcers in people with diabetes. In order to reduce the negative consequences associated with these ulcers, a consistent standard of care must be provided. This standard should combine common sense with newer technologies: appropriate wound care, debridement, and patient adherence to pressure reduction have been and will continue to be the cornerstones of treatment to avoid lower-limb amputations.

### ☒ **Stephanie Wu and David Armstrong**

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*David Armstrong is a professor of surgery, Chair of Research and Assistant Dean at the William M Scholl College of Podiatric Medicine at the Rosalind Franklin University of Medicine, Chicago, USA. He is also a member of the National Board of Directors of the American Diabetes Association.*

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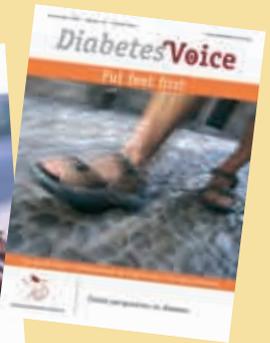
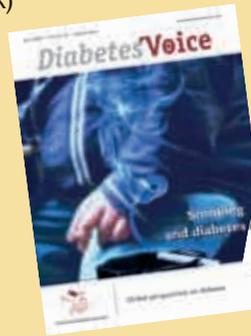
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# Appropriate footwear: sandals *or shoes?*

✉ Susan Tulley

*From the moment they are diagnosed with the condition, people with diabetes receive all kinds of advice – or at least they should – ideally from others with the condition or family members who are ‘experts’ in living with diabetes, and professional health-care providers. Of all of these recommendations, one that is often misinterpreted is that relating to ‘appropriate footwear’. The key to this lies in the word ‘appropriate’.*

>>



It should be remembered that many of the authors of articles on diabetes and footwear are based in countries which, as well as having decent podiatry services, have cold climates – predominantly the UK, northern Europe, and the USA. The recommended ‘appropriate footwear’ typically refers to a closed shoe that is made of soft leather – or something similar – with a flexible sole.

**The term ‘appropriate footwear’ is often misinterpreted.**

This advice can create problems for people reading diabetic foot literature who live in hot climates, such as in the Middle East and many other countries in the world where coincidentally there is often a higher prevalence of diabetes than in, say, northern Europe. In the Middle East, the prevalence of diabetes stands at around 26% of the population, rising to 40% in people over 60 years.

In such hot countries, advice on appropriate footwear is often understood to mean: *if you have diabetes, you must wear shoes*. Since this translates into *any shoe*, styles of footwear that would be considered inappropriate by a podiatrist – a hard, leather, slip-on shoe, for example, with a narrow toe – are often thought to be the correct protective choice. In fact, these shoes create problems with people’s feet where none existed previously.

In the Middle East it is not common to see hard skin and corns on

people’s toes, or the nail problems caused by adverse pressure; people in the region traditionally wear open-toed sandals outside the house and often walk barefoot in the home. The foot problems that do occur are commonly related to the development of hard skin on the heels, which cracks with the heat and dust, or problems on the soles provoked by burns or contact with foreign bodies. All too often, people with impaired sensation in their feet due to diabetes nerve damage step barefoot onto hot concrete or sharp objects, such as thorns, outside the house or tread barefoot on household debris while at home.

In the Middle-Eastern countries, the heels of people’s feet receive excessive exposure to the hot sun and dusty environment. Furthermore, poor-quality sandals are often to blame for foot problems: commonly, the heel of a person’s foot, when treading down, overlaps the heel of the sandal. From a podiatry point of view, only a small percentage of people with diabetes in the Middle East need specially made shoes; better sandals are required for walking outside and encouragement to wear slippers at home.

A ‘better sandal’ means one with a flexible sole, adjustable fore-foot and mid-foot straps; and most importantly either a closed-in heel or a retaining strap that prevents the person’s heel overlapping the edge of the sandal. You can see a good example on the front cover of this special issue. Additionally, for those people who require a cushioned insole, sandals with a recessed

sole to accommodate an insole should be the footwear of choice.

**We should encourage the use of sandals or slippers in the home.**

‘Appropriate footwear’, in actual fact, should refer to footwear that is appropriate to the climate of the region – whether this means good sandals or good shoes. Let us not introduce the people with diabetes who live in hot climates to ‘northern’ foot problems! We need to improve sandals to reduce the incidence of conditions such as the Middle-Eastern heel problem; and encourage the use of sandals or slippers in the home to reduce the incidence of domestic injuries.

#### ✉ Susan Tulley

*Susan Tulley is Head of Podiatry Services at the Joslin Diabetes Center Affiliate in Bahrain.*

# Foot-care education

for people with diabetes:

*a major challenge*

✉ Margaret McGill

*Although diabetes-related amputations are preventable, for too many people around the world, losing a limb or part of a limb is a tragic consequence of having diabetes. The high rates of these amputations are an indication of inadequacies in the delivery of health care, which create enormous challenges for those attempting to access high quality foot education and care. In this article, Margaret McGill focuses on current recommendations for health-care providers and makes a call for an individualized approach to diabetes foot care.*



It is well known that diabetes carries an increased risk of foot ulceration and amputation. However, it is less appreciated that amongst people with diabetes there is a wide spectrum of risk for foot complications, which should be taken into consideration when offering health advice. People with diabetes often receive the same generalized foot-care education, irrespective of their risk status.

Health professionals commonly advise people with diabetes to “be careful with your feet”. Often, such warnings are meaningless: people with low risk receive information that is not relevant to their current status; those at high risk receive advice that is too superficial for their special needs. Asking a person to examine their feet everyday, visit a podiatrist regularly and limit their

walking is optimal treatment for someone with severe diabetes nerve damage (neuropathy). But this would inappropriately and adversely affect the quality of life of another person without this diabetes complication.

**People with diabetes receive generalized foot-care education that is often inappropriate.**

## Levels of risk

Foot care is always included in self-management diabetes education programmes, regardless of the person’s level of risk. For the reasons mentioned above, the value of this approach is questionable. All people with diabetes require a foot assessment in order to be graded according to their level of risk. Based on this risk-categorization system, those with low risk who have normal feeling and normal blood flow to their feet are not at risk



of developing significant problems and thus do not require lifestyle or behaviour changes. It is important to emphasize the need for regular foot assessment in this low-risk group. Limited resources, particularly in low-income settings, should not be taken up by unnecessary treatment for people who are at low risk – and do not require referral to routine podiatry.

People with sensory neuropathy and/or decreased blood flow in the lower limbs (peripheral vascular disease), but with no ‘active’ foot problems, should be regarded as being at high risk. They require intensive

foot-care education that includes the development of practical self-care skills. They should be advised to seek routine podiatry care, if this is available.

**Those at high risk should receive intensive lifestyle education.**

Those with an active foot problem – such as an infection, ulcers or Charcot foot – are at very high risk and ideally need to be managed in a multidisciplinary foot clinic. (For more on diabetes foot complications see the articles by Vilma Urbančič-

An interactive approach to education offers opportunities to practise techniques.

Rovan and Andrew Clarke in this issue.) The people in this category should receive intensive practical education that emphasizes strategies to modify behaviour and lifestyle.

#### **Content, style and evaluation**

It is commonly but mistakenly believed that people with diabetes need to know the pathophysiology of diabetes neuropathy and vascular disease. This is

### Simple, practical advice for people at risk of foot problems

- Feel for hot spots
- Look for discoloration or swelling
- Feel for sharp toenails
- Look for ingrown nails, black nails
- Look between toes for soggy skin
- If necessary, ask a family member or friend to help.



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often the focus of foot-care education programmes. However, nature's alarm system of injury – pain – cannot be replaced by any amount of information on peripheral nerve damage. The aim of foot-care education should be to promote self-care behaviours that overcome the problems resulting from a lack of apparent symptoms.

Any education programme should reflect the urgent need to alert people to the actions or events that provoke most ulceration in people's insensate feet. These include:

- wearing ill-fitting footwear
- the development of corns and callus
- trauma from hot or sharp objects
- weight-bearing exercise.

#### Footwear

Foot ulcers are most commonly provoked by inadequate or ill-fitting footwear. Education programmes for people who are at high risk should focus on selecting and wearing new footwear; people with impaired feeling in their feet require specific information on how to select adequate footwear. These people should be advised on

the type of footwear to buy and to bring this to the foot-care team before wearing it so that it can be checked for suitability. It is also important that culturally and regionally appropriate shoes are recommended: it is unlikely that a person who lives in the tropics would wear an enclosed lace-up shoe; a sturdy sandal that protects the foot is a more reasonable alternative.

#### Callus

The perception persists amongst some people with diabetes and health professionals that callus are protective and should not be touched. The opposite is true. In people who are at high risk of foot damage, foot callus and corns indicate areas of increased pressure that are vulnerable to ulceration. It is important for people to realize that all callus and corns should be removed regularly by a podiatrist or health professional who is skilled in the technique of sharp debridement (see the article by Stephanie Wu and David Armstrong in this issue).

People with diabetes sensory neuropathy need to learn how

to inspect their feet daily for signs that may indicate trauma. Special approaches are needed for elderly people who, due to poor vision or decreased mobility, may not be able to inspect their own feet. In these cases, where possible, a family member or friend should become involved.

**Due to poor vision or decreased mobility, elderly people may not be able to inspect their own feet.**

#### Exercise

Commonly, people with diabetes are encouraged to walk as an exercise to assist with the control of their blood glucose levels. However, weight-bearing exercise in a person with insensate feet can lead to ulceration. Non-weight-bearing exercise should be encouraged, such as swimming or riding a stationary exercise bike.

As well as an emphasis on the events which lead to ulceration, a diabetes foot-care education

programme should incorporate:

- basic first-aid skills
- procedures for ensuring support should a problem with the foot arise.

**Major damage can be avoided if people know how to recognize a problem and who to contact for support.**

In targeting foot-care education to specific groups it is important to recognize that not all people who are at high risk can cope with the kind of intensive, practical education described above. It is possible that foot-care education alone has not been shown to reduce amputation rates because, when receiving this education, many people with diabetes foot damage are unwell and their ability to learn self-care strategies is reduced. Therefore, in many cases, major damage can be avoided if people know how to recognize a problem and who to contact for support.

An interactive approach to education that incorporates demonstrations and opportunities to practise foot-care techniques has been shown to better assist in changing behaviour than a lecture-style format. This education should be simple, relevant, and cyclical – repeating and recycling key information and skills work.

Written material can complement and reinforce an education programme. However, any written material should be graded for comprehension by the ‘average person’: a level of language

similar to that of a tabloid newspaper, usually for a reading age of 11 years.

All members of the diabetes team should have an adequate knowledge of diabetes foot complications. They should be able to provide education either in a structured format or when the opportunity arises. If there is a podiatrist in the team, other team members may relinquish responsibility, believing the foot is the domain of the podiatrist alone.

However, people who are at high risk, particularly those who have lost the sensation of pain in their feet, are required to remember a range of foot-care recommendations; this information should be reinforced by all team members on a regular basis.

The evaluation of diabetes foot education programmes should focus on changes in behaviour, rather than knowledge. More useful and more relevant information can be obtained, for instance, by asking people how many times in the past week they inspected their feet than by asking them to list the symptoms of neuropathy.

**More and better quality randomized controlled trials are needed.**

### Conclusion

No health-care system has unlimited resources. By grading advice and treatment, these limited health-care resources can be better utilized. This approach requires some measuring of a person’s risk of foot

ulceration. (For more on screening for foot complications see the article by Edgar Peters in this issue.)

In terms of the methodology employed, the randomized controlled trials to evaluate preventive foot-care education for people with diabetes are often of poor quality. However, some existing data suggest that self-management education may reduce the incidence of foot ulcers and amputations – especially in those who are at high risk. More and better quality randomized controlled trials are needed in order to develop and implement education strategies to reduce this devastating complication of diabetes worldwide.

### ✉ Margaret McGill

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