

# DIABETIC FOOT ULCERATION: REVIEW OF BEST PRACTICE

As the number of people with diabetes increases, the economic impact on health services will be considerable. Diabetes can also significantly impact on quality of life, physical health and mortality rates for individuals diagnosed with the condition. Foot complications represent one of the most serious and costly diabetes-related complications (Apelqvist et al, 2008).

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The number of individuals developing diabetes is increasing dramatically in the UK. The Department of Health (DoH) estimate that there are 2.35 million people with diabetes in England and this figure is predicted to rise to 2.5 million by 2010 (DoH, 2009a). There are numerous factors that have been attributed to the rise in the number of people with diabetes, for instance, an ageing population and an increase in overweight and obese people (DoH, 2009a).

It is estimated that approximately 5% of total NHS spend (and up to 10% of hospital inpatient spend) is used for the care of people with diabetes (DoH, 2009a). Department of Health figures suggest that life expectancy may be reduced by at least fifteen years for someone with type 1 diabetes, and by up to 10 years for individuals with type 2 diabetes (DoH, 2009a).



Figure 1. Diabetic foot ulcer.

As the prevalence of diabetes increases, there will inevitably

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be an increase in the chronic complications associated with diabetes, for example, foot complications which are serious and costly diabetes-related complications (Apelqvist et al, 2008).

Since the author's review article featured in *Wounds Essentials* in 2007 (McIntosh, 2007), the evidence-base for the prevention and management of diabetes-related foot complications has expanded. This paper revisits some of the established principles of best practice and explores new concepts in the management of diabetes-related foot problems.

## **Prevention of foot problems**

Effective management of the diabetic foot starts with preventative strategies.

Prevention of diabetic foot ulceration should be the primary goal for all involved in diabetic foot care. Frykberg et al (2006) suggests this is best accomplished by a number of strategies:

- ▶▶ A multidisciplinary team (MDT) approach to the management of diabetes and foot health. The team might include diabetologists, GPs, nurses, podiatrists, dietitians and orthotists, dependent on local policy
- ▶▶ Patient and family education
- ▶▶ Regular podiatry treatment, including debridement of callus and management of pathological toenails
- ▶▶ Healthcare provider education to ensure appropriate screening and recognition of risk factors for ulceration.

### Assessing the diabetic foot

As part of ongoing monitoring and prevention, all individuals with diabetes should receive regular screening to identify their risk of developing foot problems. The National Institute for Health and Clinical Excellence (NICE, 2004) advise basic foot examinations should be undertaken by appropriately trained personnel, this might include podiatrists, nurses, doctors or healthcare assistants, dependent on local policy. The Foot in Diabetes UK (FDUK) and associates (2006) highlight the fact that assessment might be undertaken by a healthcare professional with limited specialist knowledge. They suggest those involved in assessing the diabetic foot should, as a minimum, be able to:

- ▶▶ Identify sensory loss (neuropathy)

- ▶▶ Recognise when arterial blood supply to the foot is compromised (peripheral arterial disease)
- ▶▶ Identify foot deformities and other factors such as poor control of blood glucose and poor self-care that increase the risk of foot problems, including ulceration.

### Basic foot examination

The International Diabetes Federation (IDF) (2005) recommend that basic foot examination should include:

- ▶▶ Establishing whether there is a history of previous ulceration or amputation
- ▶▶ Identifying whether there is a visual or physical difficulty that prevents appropriate self-care
- ▶▶ Palpation of foot pulses — dorsalis pedis and posterior tibial pulses, capillary refill testing and ankle:brachial pressure indices (ABPI) if pulses are diminished

- ▶▶ Testing for sensory loss with a 10gram monofilament or a 128Hz tuning fork
- ▶▶ Inspection of the feet for deformities (hammer toes, clawed toes or bony prominences), toenail deformities/pathology and skin pathologies such as callus and corn.

### Identifying risk status

Evidence supports regular foot screening for all patients with diabetes to identify those at risk of foot ulceration and amputation (Singh et al, 2005). Early identification of risk factors allows practitioners to instigate prompt evidence-based strategies to prevent and manage diabetic foot problems. *Table 1* lists recognised risk factors for diabetic foot problems.

### Risk classification

Following a basic foot examination the patient can be classified according to their

**Table 1**

#### Risk factors for diabetic foot problems

<b>Peripheral neuropathy (nerve dysfunction)</b>	Sensory loss is recognised as a major cause of diabetic foot ulceration. It is estimated that 45–60% of all diabetic ulcerations are due to peripheral neuropathy, particularly sensory neuropathy (loss of feeling) (Frykberg et al, 2006)
<b>Peripheral arterial disease/ ischaemia</b>	Poor blood supply to the foot (ischaemia) is another significant risk factor for diabetic foot ulceration, which often occurs in combination with loss of sensation. An estimated 45% of diabetic ulcers are due to ischaemia and neuropathy (Frykberg et al, 2006) and are termed neuroischaemic ulcers
<b>Poor glycaemic control</b>	High blood glucose levels can increase the risk of complications arising. It is well established that high glucose levels increase the risk of vascular disease (UKPDS, 1998), but this can also give rise to neuropathy and increase the risk of infection (Falanga, 2005)
<b>Foot deformities</b>	Foot deformity is recognised as a risk factor for diabetic foot ulceration. IDF (2005) recommends regular assessment of foot deformities; hammer or clawed toes and bony prominences could be subject to high pressure and trauma particularly in the presence of sensory loss

**Table 2**

Risk classification for the diabetic foot (adapted from International Consensus on the Diabetic Foot, 1999; Frykberg et al, 2006)

Risk status	Clinical findings	Clinical review
<b>Risk 1</b> Low risk	<ul style="list-style-type: none"> <li>» No increased risk of foot problems</li> <li>» No signs of peripheral neuropathy</li> <li>» No peripheral vascular disease</li> <li>» No foot deformity</li> </ul>	» Annual review
<b>Risk 2</b> Medium risk	<ul style="list-style-type: none"> <li>» Peripheral vascular disease and/or peripheral neuropathy</li> <li>» Impaired sensation</li> <li>» Foot deformities</li> </ul>	» Every three to six months
<b>Risk 3</b> High risk	<ul style="list-style-type: none"> <li>» Peripheral neuropathy</li> <li>» Peripheral vascular disease</li> <li>» History of previous foot ulcers or amputation</li> </ul>	» Every one to six months
<b>Risk 4</b> Acute foot problems	<ul style="list-style-type: none"> <li>» Acute foot problems, e.g. ulceration</li> <li>» Ischaemia</li> <li>» Infection</li> <li>» Acute Charcot foot</li> </ul>	» Every one to seven days dependent on need

risk status. The International Consensus on the Diabetic Foot (1999) introduced a simple classification system for identifying the foot at risk (Table 2). This system has been adapted for use in other published guidelines (NICE, 2004; Frykberg et al, 2006).

Risk classification is a useful tool to inform management strategies, such as frequency of review, and to prevent foot problems from occurring.

FDUK and associates (2006) stress the importance of ensuring that healthcare professionals involved in assessing and classifying risk status are sufficiently aware of when to refer for expert opinion and advice. This includes all new episodes of foot ulceration, swelling or inflammation of the foot, unexplained pain or

any other problems that cause concern.

### Managing diabetic foot ulcers

When a patient presents with a diabetic foot ulcer, NICE (2004) recommend referral to a specialist MDT within 24 hours. The team would be expected to undertake a comprehensive assessment and develop a management based on best evidence, but also tailored to meet the needs of the patient.

The following section focuses on 10 key elements that must be addressed to achieve effective management of diabetic foot ulceration.

#### 1. Advocate tight glycaemic control

It is well established that high blood glucose levels can increase the risk of diabetes-related complications, specifically arterial disease (UK Prospective

Diabetes Study [UKPDS], 1998), neuropathy and increased risk of infection. Furthermore, high blood glucose levels can impair wound healing in established foot ulcers (Falanga, 2005). Striving to achieve tight glycaemic control is crucial in the prevention and management of diabetic foot ulcers.

The International Diabetes Federation (IDF, 2005) global guidelines advise people with diabetes to maintain blood glucose levels, as measured by the HbA1c test, below 6.5%. The HbA1c test provides a measure of glycosylated haemoglobin in the blood over a period of time, usually 2–6-monthly intervals.

#### 2. Identify aetiological factors

Initial assessment should enable practitioners to identify factors that have directly caused the ulcer, for example, ill-fitting footwear. Additionally, factors that have contributed to the ulceration and can contribute to a delay in healing should be identified, for example, peripheral neuropathy and peripheral arterial disease.

Management and prognosis differs significantly for ulcers caused by sensory loss (neuropathic ulcers), compared to those due to sensory loss combined with poor circulation (neuroischaemic ulcers) (Zimny et al, 2002). Therefore, correct identification of aetiological factors is essential from the outset.

#### 3. Establish and quantify vascular status

It is essential to determine the vascular status of the foot;

findings will largely influence ulcer management, determine the likelihood of wound healing and identify the need for revascularisation.

Basic foot examination should include assessment of vascular supply to the foot. NICE (2004), IDF (2005) and Frykberg et al (2006) recommend:

- ▶▶ Palpation of foot pulses
  - palpation of dorsalis pedis and posterior tibial pulses should be undertaken
- ▶▶ Capillary refill time. This can be a useful indicator of arterial perfusion to the toes. The test involves elevating the patient's leg slightly, and using your thumb to apply light pressure to the apex of the toe for a second or so until the skin is blanched. Then release the pressure and count in seconds how long it takes the skin to return to its normal colour. Normal capillary refill times are around 2–3 seconds in warm weather and 4–5 seconds in cold weather
- ▶▶ Determining whether the patient is experiencing vascular symptoms, for example, intermittent claudication (i.e. pain in the calves on walking)
- ▶▶ Assessing the legs and feet for signs of arterial disease, for example, pale skin particularly on elevation
- ▶▶ If pulses are not palpable or arterial disease is suspected, other tests such as Doppler examination and ABPI should be undertaken
- ▶▶ If there is concern of significant peripheral arterial disease, expert advice from the vascular team should be sought.

#### 4. Manage arterial risk factors

Certain factors are known to increase the risk of arterial disease, for example, high blood pressure and high cholesterol. These factors should be identified and a team approach adopted to introduce management strategies that aim to minimise arterial complications.

The IDF (2005) recommend target blood pressure measurement below 130/80mmHg, which might be achieved by a combination of drugs and lifestyle modification or lifestyle modification alone. Modifiable factors that can help here include reduced salt and alcohol intake, weight loss and increased activity.

Dyslipidaemia (abnormal lipid levels in the blood) and smoking can also increase the risk of arterial disease. Again, lifestyle changes such as weight loss, positive dietary changes, increased physical activity and smoking cessation should be encouraged (IDF, 2005).

In 2008 the Department of Health launched a national initiative entitled 'Putting Prevention First'. This initiative sets out plans for the NHS to deliver a national programme of vascular checks which will:

- ▶▶ Be for everyone aged 40–74
- ▶▶ Adopt a systematic call and recall approach
- ▶▶ Ask simple questions about height, weight, family history and lifestyle
- ▶▶ Include tests for cholesterol and, in some cases, glucose
- ▶▶ Assess vascular risk and offer appropriate lifestyle and, if

necessary, pharmaceutical interventions (DoH, 2009b).

#### 5. Rapid management of infection

Foot infections are common in people with diabetes. A large proportion of patients with diabetic foot ulceration will develop infection, including osteomyelitis (bone infection) and gangrene (O'Meara et al, 2006). Infection in the diabetic foot can spread rapidly leading to tissue destruction and amputation (Edmonds, 2005). Infection can pose a serious complication in diabetic foot wounds, with infected ulcers taking longer to heal and further increasing the risk of amputation (Stanaway et al, 2007). Early identification and prompt management of infection is crucial to prevent limb loss.

Recognising infection in the diabetic foot is often difficult; up to 50% of patients with infected diabetic foot ulcers will not show classic signs of infection (Edmonds and Foster, 2006). This is due to a poor blood supply that reduces inflammation, redness and heat, and neuropathy that will mask pain. Practitioners must be aware of other signs of infection, such as an increase in exudate volume and malodour (Cutting et al, 2005).

Frykberg et al (2006) advise all diabetic foot infections should be monitored closely. Management will depend on severity of infection. Non-limb threatening infection can be managed on an outpatient basis. Berendt et al (2008) suggest that antibiotic regimes



<b>T</b>	Tissue viable or non-viable
<b>I</b>	Infection or inflammation
<b>M</b>	Moisture imbalance
<b>E</b>	Epithelium advancing or undermining

Figure 2. TIME to Heal, adapted from Watret (2005).

should be as targeted and narrow spectrum as possible.

Individuals with limb-threatening infection require hospital admission for intravenous antibiotic treatment and possibly surgical procedures to remove necrotic and infected tissue and/or bone (Berendt et al, 2008).

## 6. Identify wound characteristics

The TIME acronym for assessing the wound bed is now a well established clinical tool (Figure 2) (Schultz et al, 2003).

**Tissue** removal of dead or devitalised tissue is paramount for effective wound bed preparation. Frykberg et al (2006) advocate regular debridement to remove necrotic tissue and reduce bacterial burden in order to expedite wound healing. Sharp debridement, by a skilled practitioner, is probably the most frequently used method for removing dead or devitalised tissue on the diabetic foot. However, in some cases, for example in the presence of ischaemia, sharp debridement may be inappropriate and other types of debridement, such as larval therapy or topical negative pressure, should be considered.

Emerging scientific evidence supports the use of topical negative pressure (TNP) to facilitate the healing of diabetic foot ulcers. Eneroth and van Houtum (2008) reviewed the evidence base for TNP and concluded that it is a

**Emerging scientific evidence supports the use of topical negative pressure (TNP) to facilitate the healing of diabetic foot ulcers.**

safe, effective treatment for complex diabetic foot wounds, which could lead to a higher proportion of healed wounds, faster healing rates and potentially fewer amputations.

**Inflammation or infection:** prompt recognition and management of infection is vital for healing, refer to point 5 ('rapid management of infection').

**Moisture imbalance:** a moist wound environment is known to encourage healing by promoting granulation and encouraging autolytic debridement (the body's own form of wound debridement) (Frykberg et al, 2006). However, moisture balance must be maintained to prevent the wound bed becoming too dry or too moist, both of which could contribute to a delay in wound

healing. There is currently no scientific evidence to suggest that one type of wound dressing is superior to another in treating diabetic foot ulcers. Dressing selection should aim to ensure moisture balance and create an optimum environment for healing.

**Epithelium advancing or undermining:** the wound edges should be examined to determine whether epithelium tissue is advancing, or whether the wound is undermined. The surrounding skin should also be examined for the presence of non-viable tissue such as callus. Watret (2005) stresses the importance of regular callus debridement by a skilled podiatrist in the healing of diabetic foot ulcers.

## 7. Establish and quantify neurological complications and pain

Peripheral neuropathy is a well known risk factor for diabetic foot problems; as many as 45–60% of all diabetic ulcerations are purely neuropathic, while approximately 45% are neuroischaemic (Frykberg et al, 2006). Neurological status must therefore be established by the use of a 10g monofilament to test for light touch and vibration perception testing, with a tuning fork or neurothesiometer. Increasing evidence suggests that peripheral neuropathy can impair mobility through altered balance and posture (van Schie, 2008). Patients with peripheral neuropathy may report instability while walking or standing, which might impinge on their quality of life. The presentation of peripheral neuropathy can vary from

painless to painful. Chronic neuropathic pain has been observed in 8–26% of patients with diabetes, yet evidence suggests that many patients do not receive treatment (Ziegler, 2008). Neuropathic pain can have a significant impact on quality of life through persistent or episodic pain, sleep interference and altered gait (Ziegler, 2008). Patients with painful diabetic neuropathy may benefit from drugs such as amitriptyline hydrochloride (tricyclic antidepressant), which have been shown to reduce symptoms (Scottish Intercollegiate Guidelines Network [SIGN], 2001).

## 8. Employ offloading strategies

Pressure reduction or offloading is a key aspect of any plan aimed at preventing and healing diabetic foot ulcers. Offloading the ulcer site prevents further trauma and facilitates wound healing, this is particularly important if the patient has sensory neuropathy (Frykberg et al, 2006). There are numerous modalities available to offload diabetic foot ulcers and choice will be dependent on a number of factors; patient preference, ability to comply, severity of the ulcer and available resources (see pp. 117–121 in this publication).

Therapeutic footwear has also been shown to have a beneficial role in the primary and secondary prevention of diabetic foot ulcers (Maciejewski et al, 2004; see pp. 112–115 in this publication).

## 9. Multidisciplinary team approach

Frykberg et al (2006) advocate a

team approach to the prevention and management of diabetic foot problems, including non-specialist and specialist practitioners providing coordinated care. The benefits of multidisciplinary working in diabetic foot care are well established (Edmonds et al, 1986); hence, clinical guidelines advocate a team approach to diabetic foot care (NICE, 2004; IDF, 2005).

## 10. Structured education

Increasingly, healthcare professionals are recognising the importance of structured education in equipping people with diabetes to manage their own condition (DoH, 2009b). Structured education is an essential component of every patient care plan. Both the IDF (2005) and FDUK and associates (2006) advise that practitioners should explain the reason for foot screening and discuss with the patient their individual level of risk. This will promote patient-centred care and, through negotiation, plans for future surveillance can be agreed.

Additionally, FDUK and associates (2006) recommend that healthcare professionals involved in diabetic foot care should, as a minimum:

- ▶▶ Recognise the need for and initiate appropriate referrals for expert review
- ▶▶ Advise patients on the best course of action to be taken if an ulcer or a new lesion occurs
- ▶▶ Provide appropriate footwear advice that will minimise ulceration risk
- ▶▶ Advise on basic foot care to reduce ulceration risk.

The above strategies combined with optimal glucose levels and appropriate lifestyle change, should help to minimise ulceration risk and promote healing in the case of established foot ulcers.

## Conclusion

Prevention of diabetic foot ulceration should be the primary goal for all involved in diabetic foot care. This can be achieved with regular risk assessment, risk classification and coordinated diabetes care from both non-specialist and specialist healthcare practitioners. In the case of established diabetic foot ulcers, coordinated care from a network of skilled professionals is crucial to ensure management strategies are based on best evidence, address clinical guidelines while also meeting the needs of the patient.

This article has explored 10 key areas to encourage an evidence-based, systematic approach to diabetic foot ulcer management. **WE**

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### Key points

- ▶ The number of people with diabetes is increasing.
- ▶ The economic impact of diabetes on health services will be considerable.
- ▶ Foot complications represent one of the most costly and serious complications of diabetes.
- ▶ Effective management of the diabetic foot starts with preventative strategies
- ▶ All individuals with diabetes should receive regular screening to identify their risk of foot problems.

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