Management of diabetes-related foot ulcers: optimising outcomes

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Timely referral of patients to specialist multidisciplinary foot care services for intensive, comprehensive treatment of new onset foot ulcers is key to optimising outcomes. Continuity of care between the primary care setting and hospital services should be seamless to prevent unnecessary delays and to improve outcomes in affected patients.

Key points

- **Diabetes-related foot ulceration is common and affects up to one-quarter of people with diabetes mellitus.**
- **Key elements in managing diabetes-related foot ulcers are achieved by thorough assessment of the wound, the affected foot and the patient, followed by co-ordinated multidisciplinary care.**
- **Early assessment and appropriate referral of patients with diabetes-related foot ulcers, ideally to a specialist multidisciplinary foot care team, are key to optimising outcomes.**
- **Main elements of treatment of diabetes-related foot ulcers include individualised care in ulcer debridement and dressings, use of antibiotic therapy where indicated, pressure offloading, and, in some cases, referral of patients for consideration of revascularisation or orthopaedic foot surgery.**
- **With timely correct care, most diabetes-related foot ulcers will heal conservatively and patients requiring amputation will have tissue loss minimised and foot function maximised.**

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Diabetes-related foot complications are common, with approximately 15 to 25% of people with diabetes developing a foot ulcer at some point during their lifetime. In the authors' experience, foot ulcers are often not managed well and referral of patients is delayed, which leads to an increase in the likelihood of amputation.[1]

This article focuses on the key elements in managing diabetes-related foot ulcers. It is a follow up to the article 'Prioritising assessment of 'at-risk' feet in diabetes: individualising foot care', which addressed stratified foot assessment and management, and was published in the October 2012 issue of *Endocrinology Today*.[2] Key recommendations as outlined in the 2011 NHMRC *National Evidence Based Guidelines on Prevention, Identification and Management of Foot Complications in Diabetes* are highlighted in this article.[1] In addition, the authors' clinical experiences at the Diabetes Centre High Risk Foot Service at Royal Prince Alfred Hospital in Sydney are incorporated and information is provided to health professionals on diabetes-related foot ulcers from a primary care perspective.

Diabetes-related foot ulcers are serious and their successful management relies on co-ordinated interdisciplinary shared care by skilled health care professionals across primary care and hospital-based services. Early assessment and appropriate referral of patients, ideally to a specialist multidisciplinary foot care team, is key to facilitating intensive intervention towards ulcer healing and in amputation prevention (NHMRC evidence-based recommendation 9, Grade C).[1] The box on this page summarises the main factors that should precipitate referral of patients with diabetic foot ulcers to specialist foot care teams.[1,3] These teams should comprise medical, surgical, nursing, podiatry and other allied health professionals with adequate resources, skills and knowledge not only in limb salvage but ultimately in preserving a functional limb.

If access and referral to a single centre multidisciplinary team is limited, patients as a minimum should be assessed by a doctor, podiatrist and/or wound care nurse. In rural and regional settings, where expert consultation through digital imaging and telehealth medicine is available, referral should be arranged as soon as is possible (NHMRC evidence-based recommendation 10, Grade C).[1]

Factors that should always precipitate referral of patients with diabetes-related foot ulcers to a multidisciplinary foot care team[1]

- Deep ulcers (probe to capsule, joint or bone)
- Ulcers not reducing in size after four weeks despite appropriate treatment[3]
- Absence of palpable foot pulses
- Ascending cellulitis
- Suspected Charcot's arthropathy (e.g. unilateral red, hot, swollen, with or without a painful foot)

Common risk factors for ulceration

Although many foot ulcers appear to occur spontaneously, it is the combination of peripheral neuropathy, peripheral arterial disease (PAD) and foot deformity that places the diabetic foot at high risk of ulceration. Peripheral neuropathy is the key predisposing factor and results in the loss of protective sensation and lack of awareness of abnormal forces and trauma to the foot. This can lead to skin breakdown and subsequent ulceration. It can be the result of intrinsic factors such as foot deformity, and/or abnormal foot biomechanics or external factors such as trauma from poor fitting footwear.[4] Whatever the cause, due to the insensate nature of peripheral neuropathy, patients continue to walk and in many instances are unaware that a foot ulcer has developed. This in turn often causes a delay in seeking medical treatment and can have a profound effect on outcomes. The presence of PAD in combination with neuropathy then contributes to slow or complete inability of the wound to heal and increases the risk of infection and amputation.[5] Therefore, in the authors' experience, once an ulcer has developed prompt referral of the patient to specialist services should not be delayed. The average time of presentation of a new ulcer from its historic onset to the authors' service is about one month, with marked variation, and this time interval has appropriately reduced in recent years.

Assessment of foot ulceration

A thorough history should be taken and a foot assessment performed on both feet as outlined in the previous article published in *Endocrinology Today*.[2] A foot assessment will facilitate identification and define the aetiology of the ulcer. Errors are made if all ulcers are treated the same. Most diabetes-related foot ulcers can be classified as neuropathic, neuroischaemic or ischaemic (see Figures 1, 2 and 3).

Assessment of the wound and its location can also aid in classifying the ulcer type. Wound assessment should include an evaluation and documentation of the ulcer with respect to size and depth (which may involve the use of a sterile probe), exudate level, odour, and condition of the wound base and edges and surrounding skin, as well as signs of contamination and clinical signs of infection.[6]

To determine ulcer severity a grading system can be used. A commonly used and validated grading system is the University of Texas wound grading system (see Table),[7] which has two main components. The stage identifies infection and ischaemia, and the grade identifies the depth. The use of this grading system provides a standardised approach and allows for more accurate communication between all health care providers (NHMRC evidence-based recommendation 5, Grade C).[8]

Assessment of foot infection

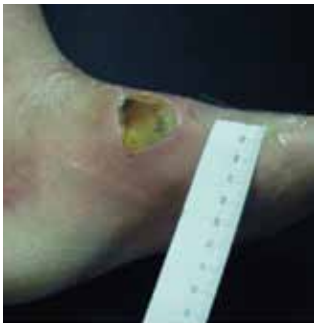
The diagnosis of infection should always be made clinically, not microbiologically. The presence of purulent secretions or two or more signs of inflammation, such as swelling, warmth and erythema, indicate infection and therefore antibiotics should be commenced. Signs and symptoms such as pain, erythema and fever are often reduced or absent, especially in people with PAD and peripheral neuropathy, and many patients present with quite severe infection without these clinical features.[9] In the authors' experience, assessment for infection is often inadequately performed. The examination should include assessment of both the dorsal and plantar aspects of the feet, between the toes and all the way up the legs to the knee. If assessment of the affected foot is made in isolation, swelling caused by infection is often under-recognised. Interdigital areas are also often poorly examined and fungal infections are commonly missed and account for many hospital admissions for cellulitis.

There is growing evidence that wound swabs are of little clinical benefit; however, if a swab is collected, for example to assess for Methicillin-resistant *Staphylococcus aureus* (MRSA) or a nonhealing ulcer, the wound should be thoroughly cleaned or debrided before the swab is taken. Tissue samples provide more accurate specimens for culture if they can be collected during debridement.[9]

Diagnosis and treatment of osteomyelitis

There should be a high level of suspicion for osteomyelitis, especially if the ulcer is infected, deep, or large and chronic. Many ulcers may appear superficial but may be close to bone, especially when the ulcer

Figure 1. Neuropathic ulcers typically occur on the plantar surface of the foot or over areas of high pressure and are associated with callus formation.



Figures 2a and b. Ischaemic ulcers tend to occur on the toes and borders of the feet and have little or no callus.

Figure 3. Neuroischaemic ulcers are a combination of the two pathologies but one process is usually more dominant.

Table. The Texas Classification System for diabetic foot wounds[7]

STAGE	GRADE			
	0 Pre- or post-ulcerative lesion completely epithelialised	1 Superficial wound, not involving tendon, capsule or bone	2 Wound penetrating to tendon or capsule	3 Wound penetrating to bone or joint
A Not infected or ischaemic				
B Infected				
C Ischaemic				
D Infected and ischaemic				

Adapted from: Armstrong DG, Lavery LA, Harkless LB. Validation of diabetic wound classification system. Diabetes Care 1998; 21: 855-859.[7]

overlies a bony prominence such as a claw or hammer toe. Classic clinical signs of digital osteomyelitis include the 'sausage toe' (an example is shown in Figures 4a and b). The authors suggest using the 'probe to bone' test for all ulcers to assess depth. If osteomyelitis is suspected clinically and the probe contacts bone, the likelihood of osteomyelitis is high when the test is performed accurately.[9] A plain x-ray is recommended as a baseline for all infected diabetic foot ulcers and, if osteomyelitis cannot be confirmed on initial x-rays, then serial x-rays can be taken at four- to six-weekly if suspicion is high. This time interval is also used to monitor for osteomyelitis in patients being treated conservatively with antibiotics.

Although MRI may be considered a better diagnostic tool for osteomyelitis, in the authors' experience most cases can be diagnosed based on careful clinical assessment combined with serial plain x-rays. CT scans with bone windows also have a use. If a white cell scan is considered, this should be carried out in conjunction with a bone scan so results can be localised for bone infection. The most definitive way to diagnose osteomyelitis remains through bone biopsy with radiological guidance; however, this can be difficult to perform and is invasive.[9] It is not the authors' practice to use this method for diagnosis.

Figures 4a and b. Osteomyelitis of the toe leading to the classic 'sausage toe' appearance.

Treatment and management of osteomyelitis depends on the location and extent of infected bone and the response to empiric treatment. Discussion remains focused on the surgical approach to all infected bone versus medical strategies with antimicrobial therapy. In noncomparative studies each approach has successfully resolved infection in most patients.[9] At the high risk foot service at the Royal Prince Alfred Hospital, Sydney, patients with minimally invasive osteomyelitis have been successfully treated with antibiotics. There is a lack of evidence to support any particular route of therapy or the optimal duration of antibiotics.[1] The Infectious Diseases Society of America recommends treating nonsurgical cases with more than four weeks of antibiotics. In the authors' experience complete healing has been achieved in many cases using antibiotics for eight to 12 weeks. For people who fail to respond to antimicrobial therapy and/or the extent of bone destruction is too great, referral for surgical intervention should be arranged as soon possible.

Selection of antibiotic therapy

Infection alone is a major precursor to amputation and, therefore, if the ulcer is infected, antimicrobial therapy should be commenced empirically and immediately.[9] Diabetic foot infections are often worse than they appear and should always be regarded as serious. Waiting for swab results is not advisable. The route of therapy will depend on the severity and extent of the infection. In an outpatient setting, oral antibiotics are most often used and a combination of antimicrobials may be prescribed initially to control infection and help prevent hospital admission. Acute infections in patients who have not recently received antimicrobials are usually due to *S. aureus* and streptococci.

Chronic infections are often polymicrobial, including Gram-positive and Gram-negative aerobes and anaerobes. The empiric antibiotic therapy should therefore cover *S. aureus* and consideration should also be made for anaerobe cover.[10] Oral agents commonly used within the authors' service include dicloxacillin, clindamycin or amoxycillin with clavulanic acid. In patients allergic to penicillin, ciprofloxacin and/or clindamycin are used. For infections involving necrotic tissue or malodour, antianaerobic agents such as metronidazole are frequently added. If MRSA has been isolated, rifampicin and sodium fusidate can be used in combination. The regimen dosage may in time be reduced depending on clinical response and antibiotic therapy should only be ceased following resolution of infection. An example of localised soft tissue infection that could be treated with oral antibiotics is shown in Figure 5.

In patients with severe infection or if use of oral antibiotics appear unable to adequately control the infection, parenteral antibiotics are required. Severe infection can be signified by systemic toxicity/septic shock, bacteraemia, marked necrosis/gangrene, ulceration to deep tissues or severe cellulitis, and patients with any of these symptoms will usually require hospital admission. Parenteral antibiotic therapy can be given in hospital, or on an outpatient basis in milder clinical cases if a 'Hospital in the Home' or similar program is available. Examples of generalised infection requiring urgent parenteral antibiotics are shown in Figures 6a and b.

In the authors' experience, co-ordinated care with GPs in primary care is an important component of managing patients with infection. Continuity of antimicrobial therapy following discharge from hospital or between specialist clinic appointments can prevent worsening or recurrence of infection, as antibiotics are typically required for longer than a single course.

Figure 5. Localised soft tissue infection of the hallux.

Figures 6a and b. a (left). Infection of the foot and leg extending to the knee. b (right). Generalised infection of the foot. In both cases, the patient requires hospital admission for parenteral antibiotics.

Assessment for revascularisation

Palpation of pedal pulses is a simple test but remains one of the most important components of assessing peripheral blood flow that will facilitate healing. In most cases, if pedal pulses are palpable in the absence of other clinical signs there is adequate perfusion for healing. If foot pulses are impalpable or waveforms are reduced on a handheld Doppler and/or the patient has clinical signs of PAD, referral should be made for an ankle brachial pressure index or toe brachial pressure index and arterial duplex scan. If the ankle brachial pressure index and duplex are abnormal, prompt referral of the patient should be made to a vascular surgeon who will assess whether the disease is amenable to vascular intervention to improve healing potential.

Debridement of the ulcer

Debridement is an essential component of wound bed preparation to facilitate healing. It is of key importance for ulcers with a significant neuropathic component but is not always required or possible when treating neuroischaemic or ischaemic ulcers. This again highlights the importance of defining the ulcer aetiology and subtype to determine the level of debridement that can be performed safely. Debridement involves the regular and repeated removal of periwound callus as well as necrotic, sloughy tissue from the wound bed to aid in reducing bacterial burden, promoting granulation tissue and converting a chronic wound into an acute state.[11] Although there are many forms of debridement, local sharp debridement using a scalpel and/or curette is the preferred method, given that it can be performed chair side, quickly and effectively by a member of the specialist foot care team, usually a podiatrist trained in wound debridement. Although evidence on the extent and frequency of debridement is undefined, in the authors' experience most neuropathic ulcers need to be debrided every one to two weeks. Figures 7 and 8 provide examples of the extent of sharp debridement that can be performed.

Reducing pressure on the ulcer

In addition to appropriate debridement, regardless of ulcer type, pressure relieving devices should be used to reduce ongoing trauma and pressure at the ulcer site, which frequently delays or prevents healing.[12] It is essential to provide pressure offloading in the short term to heal the ulcer and in the long term to prevent ulcer recurrence. Although all patients are encouraged to reduce and minimise weight-bearing and standing activity on the affected foot, and this may include taking time off work, it is unrealistic to expect complete nonweight bearing for the time required for healing. Due to the lack of pain and sensory feedback, patients often continue to walk more than the recommended amount despite such advice. Pressure redistribution, or 'pressure offloading' as it is most commonly referred


Figures 7a and b. a (left). Predebridement of callus apex of the toe. b (right). Postdebridement of callus to reveal ulceration.


Figures 8a and b. a (left). Predebridement of an infected blister. b (right). Postdebridement of blister to reveal extent of ulceration and infection.




Figures 9a to d. a (top left). Postoperative shoe. b (top right). Felt deflective padding. c (bottom left). Prefabricated cast walker. d (bottom right). Total contact cast.

to, can be achieved using a range of different modalities. Selection depends on the ulcer location, aetiology, presence of infection, and the patient's level of mobility, occupation and acceptance of the treatment. Most short-term pressure offloading strategies require patients to be taken out of their normal everyday footwear and fitted with temporary offloading devices that should be worn at all times (see Figures 9a to d).

Although total contact casting remains the gold standard, prefabricated cast walkers have been shown to be just as effective with regards to rate and time to healing when they are rendered irremovable.[13] Irremovable devices may be required for treatment adherence but this may not always be possible or suitable. Whatever offloading device (boot or shoe) has been selected, additional pressure offloading using either semicompressed felt or a total contact orthotic is also required. Depending on the response, these strategies should be reassessed at each visit and may need to be modified or replaced with alternative methods for healing to occur.

Footwear and orthoses play a key role in the prevention of foot ulceration as well as ulcer recurrence despite poor evidence on their effectiveness.[1] This poor evidence is thought to be mainly due to poor adherence in wearing the prescribed footwear. If the patient's foot shape is normal, recommendations may include sports style or walking shoes with soft cushioned soles and laces. Careful fitting of these shoes is important. If the patient has a foot deformity (e.g. partial foot amputation, chronic Charcot's arthropathy or claw toes), shoe fitting is difficult and medical grade footwear and orthoses are then recommended (see Figure 10). This involves assessment and referral of the patient to a podiatrist or specialist in the multidisciplinary team. Medical grade footwear and orthoses can be expensive and require regular review and replacement due to continual everyday use. In many instances, if patients cannot afford this type of footwear, funding can be sought through government initiatives.

Surgery to correct chronic deformities to reduce the risk of further ulceration should be assessed, particularly if footwear has been tried but was not successful.

Choice of ulcer dressings and other topical treatments

Dressings alone will not heal foot ulcers. They should be viewed as an adjunct to treatment and do not negate the need for antibiotics (if infection is present), debridement, offloading and/or vascular intervention. Indeed, local wound care is more about what is taken off the wound rather than what is put on.[11] Dressings should provide a clean, moist wound environment with adequate control of wound exudate and should protect the healing tissue from the environment. In cases of ischaemic dry necrotic wounds, care should be taken to maintain a dry wound environment, and dressings that aid in autolytic debridement should be avoided (NHMRC expert opinion).[1]

Little evidence exists to support the use of any specific dressing over another for foot ulceration; however, expert consensus suggests foam dressings, particularly those that can withstand large amounts of pressure under weight-bearing forces. Care should be taken to avoid packing ulcers with sinuses or cavities on the plantar surface of the foot, as well as occlusive, bulky dressings. Other dressings

Figure 10. Medical grade footwear and custom moulded orthoses.

commonly used include absorbent dressings, silicones, hydrogels, alginates, hydrofibres and antimicrobials such as cadexomer iodines and silver dressings. Antimicrobial dressings are expensive and ideally should be used within specialist clinics. If access to dressings is limited, foam dressings can be used on most ulcer types safely.

Leg oedema requires careful assessment to determine its cause, and its therapy is important to help minimise variations in general foot and periulcer pressure. For more complex, large and/or deep wounds, negative pressure wound therapy may be used in specialist centres (NHMRC evidence-based recommendation 11, Grade B).

Other ulcer therapies including hyperbaric oxygen therapy, larval (maggot) debridement therapy, bioengineered tissue, growth factors and stem cells may be considered on a case-by-case basis in specialist centres when all other aspects of treatment have been considered. They should form part of a comprehensive wound management plan (encompassing NHMRC evidence-based recommendation, Grades B to D).[1]

Holistic treatment

It is important to remember that holistic care of the person with diabetes and a diabetic-foot ulcer is essential. Although improving blood glucose levels has not been shown to aid ulcer healing in people with diabetes, avoiding symptomatic hypoglycaemia or hyperglycaemia as the infection is treated is required in parallel with ulcer care. Psychological support, sick-leave certification sometimes for significant time intervals depending on the nature of work, and care of cardiovascular disease risk factors all need to be considered.

Conclusion

Healing of diabetic foot ulcers can be achieved in about two-thirds of patients within eight weeks if treatment is based on the principles outlined in this article (see the summary in the box on this page). Timely referral of patients to specialist multidisciplinary foot care services for intensive, comprehensive treatment of new onset foot ulcers is key to optimising outcomes. Continuity of care between the primary care setting and hospital services should be seamless to prevent unnecessary delays and to improve outcomes. Ulcer recurrence is common and on average occurs twice in a patient's lifetime, reinforcing roles for ongoing preventive podiatry care and education. Cardiovascular risk factors and comorbidities in people with diabetic foot ulcers also require treatment to aid longevity and quality of life. **ET**

Key components in the management of diabetes-related foot ulceration

- Assess the foot and wound
  - identify underlying cause(s) for the ulcer
- Carefully stage and grade the ulcer type
  - identify and treat clinical infection
- Arrange investigations
  - plain x-rays, baseline blood tests
- Institute wound care including debridement and dressings
- Offload pressure
- Manage the patient holistically (e.g. oedema, cardiovascular disease risk factors, blood glucose deterioration, psychological state, time off work)
- Arrange timely referral where indicated to a high risk foot service

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