Assessment of diabetic foot ulcers: back to basics

Abstract

Diabetic foot ulceration affects up to 34% of the global diabetic population as a result of poor glycaemic control. Complications resulting from diabetic foot ulceration can be complex, expensive and challenging. It is important for risk factors to be recognised early and for regular assessment to take place. Streamlining a coordinated approach that enhances communication and guides treatment approaches can help to improve wound outcomes.

Key words: ■ Diabetic foot ulcers ■ Wound care ■ Assessment ■ Management

Article:

It is estimated that diabetes affects 537 million people worldwide and, as a result of poor glycaemic control, diabetic foot ulceration affects up to 34% of the global diabetic population (Schaper et al, 2020). The impact of complications resulting from diabetic foot ulceration can be complex, expensive and challenging. It is important for risk factors to be recognised early and for regular assessment to take place. Streamlining a coordinated approach that enhances communication and guides treatment can help to improve wound outcomes. This is a back-to-basics paper on the assessment of diabetic foot ulcers (DFUs) for clinical practice.

Poorly controlled diabetes frequently results in complications that predominantly affect the lower limbs, presenting complex and expensive challenges. One of the most typical complications associated with uncontrolled diabetes is the development of DFUs. It is estimated that between 19% and 34% of the global diabetic population will experience a DFU in their lifetime (Armstrong et al, 2017), with the global prevalence being higher among

patients with type 2 diabetes mellitus (T2DM). This discrepancy may reflect the younger age, longer disease duration and limitations in research specific to cohorts of people with type 1 diabetes (Zhang et al, 2017).

About 20% of individuals who develop a DFU will undergo either a minor (below the ankle) or major (above the ankle) lower limb amputation; some may undergo both (Armstrong et al, 2017). Furthermore, an estimated 10% of patients will die within the first year following a DFU diagnosis (Meloni et al, 2020). Such severe outcomes typically stem from insufficient glycaemic control, underlying neuropathy, peripheral vascular disease or inadequate foot care. Thus, it is crucial that health professionals understand the manifestations and epidemiology of DFUs, including associated complications.

A DFU is identified as a break in the epidermis that extends to at least a portion of the dermis in individuals with diabetes. Superficial or sealed lesions on the foot that do not reach the dermis (eg callouses, blisters, warmth or erythema) carry a high risk (Table 1) and can be categorised as pre-ulcerative. The aetiology of DFUs can be divided into two types (Table 2):

- Neuropathy: this entails peripheral nerve damage, leading to diminished foot sensation
- Ischaemia: a reduction in the arterial blood supply to tissues, causing a decrease in oxygen and nutrients to cells, potentially resulting in tissue death.

Table 1

Age	The risk escalates with both age and the duration of diabetes as a result of the cumulative impacts of hyperglycaemia and micro/macrovascular complications. Younger or middle-aged patients often exhibit advanced ulceration, infection and hospitalisation
Sex	The incidence is estimated to be 1.5 times higher in men than in women (Zhang et al, 2017). These disparities are generally attributed to underlying risk factors, access to care, treatment adherence, use of appropriate footwear, and an increased incidence and risk of peripheral neuropathy, peripheral arterial disease and cardiovascular disease
Weight	A lower body mass index is associated with a higher risk of amputation and mortality. While there is a lack of concrete evidence linking obesity to the occurrence or recurrence of DFUs (Zhang et al, 2017), some studies suggest that obesity might increase atherosclerosis, thereby reducing blood supply to the lower limbs (Alexet al, 2010)
Race and ethnicity	Research indicates that Black, Hispanic and other non-white groups exhibit a higher rate of diabetes and DFUs than white adults

	(Canedo et al, 2018; Centers for Disease Control and Prevention, 2022)
Socioeconomic factors and geography	These elements often intersect with racial and ethnic disparities. Inequitable access to care in low-income, deprived areas might contribute to disparate outcomes in DFU care. Moreover, higher levels of education are associated with a lower risk of DFUs (Ouyang et al, 2021)
Glycaemic control	Poor glycaemic control, which leads to elevated haemoglobin A1c (HbA1c), poses a risk for DFUs, amputation and mortality following a DFU. Lower HbA1c levels can delay microvascular complications and amputation (Goldman et al, 2018)
Comorbidities	DFUs and cardiovascular disease are indicators of diabetes severity and duration, resulting in increased inflammatory markers, a procoagulable state and loss of functional status (Dietrich et al, 2017). End-stage chronic kidney disease is associated with a higher incidence of DFUs, increased ulcer recurrence rates and higher lower limb amputation rates (Ndip et al, 2010)

Lack of exercise	Diabetic patients with lower levels of physical activity have a higher likelihood of foot ulceration (Atkin et al, 2018). Exercise promotes vasodilation and increased blood flow to tissues
Smoking	Smoking amplifies the risk of peripheral neuropathy in adults, risk factors for peripheral arterial disease and the incidence of DFUs (Zhang et al, 2017)
Poorly fitting footwear	Footwear that does not fit properly can cause trauma to areas of the foot, potentially leading to ulceration

Table 2

Purely neuropathic	These ulcers are painless, have a ‘punched-out’ appearance and are usually found on the weight-bearing parts of the foot. They are characterised by elevated, macerated or undermined margins, surrounded by thick callouses

Purely ischaemic or mixed neuroischaemic	Typically, these present as irregular lesions with a pale or necrotic base, occasionally accompanied by gangrene or round ulceration at points on the foot where tissue ischaemia and friction occur, such as the dorsal surfaces of toe joints. These ulcers tend to be larger than neuropathic ulcers on the mid or hind foot and may manifest complications such as cellulitis, abscesses or osteomyelitis (Yotsu et al, 2014)

It is worth noting that the prevalence of peripheral neuropathy and peripheral vascular disease tends to increase with an individual's age, the duration of their diabetes and having sustained elevated haemoglobin (Hb) A1c levels.

Risk factors

The risk of developing a DFU is influenced by both individual patient characteristics and specific foot-related factors (Table 2). A foot categorised as ‘at risk’ necessitates increased levels of screening, monitoring and evaluation. Moreover, socioeconomic circumstances and access to care can significantly impact the outcomes of DFUs (Canedo et al, 2018; Tatulashvili et al, 2020; Zhang et al, 2021).

To streamline the treatment and management of DFUs, health professionals can use classification and scoring systems from the International Working Group on the Diabetic Foot's (IWGDF) classification guidelines (Schaper et al, 2023). These serve as guidelines that aid in enhancing communication, guiding treatment approaches and improving wound outcomes.

Classification

Diabetic foot ulcers are classified into five distinct stages:

- Stage 1: no risk factors identified
- Stage 2: physiological risk factors identified (Table 3)
- Stage 3: ulcerated foot
- Stage 4: infected foot
- Stage 5: necrotic foot.

Table 3

Development of a callus	This is often a result of motor neuropathy, which leads to physical deformities of the foot and sensory neuropathy, which results in sensory loss. Persistent abnormal pressure in the foot as a result of ongoing trauma can cause the formation of a callus (Arosi et al, 2016)
Peripheral motor neuropathy	This condition can lead to abnormal foot anatomy and biomechanics, clawed toes, a high arch and the partial dislocation of the metatarsophalangeal joints. These changes can result in excess

	pressure, callus formation and, ultimately, ulceration (Packer et al, 2023)
Peripheral sensory neuropathy	This is characterised by a lack of protective sensation, which can result in minor injuries from pressure, mechanical, traumatic or thermal damage
Peripheral autonomic neuropathy	This condition can lead to dry, cracking skin, which is caused by a deficiency in sweating
Neuro-osteoarthropathy deformities	These include conditions such as Charcot disease (a group of disorders that damage peripheral nerves) or limited joint mobility (Packer et al, 2023)
Abnormal anatomy and biomechanics	This can result in excess pressure, particularly in the plantar region
Arterial insufficiency	This can hinder wound healing by reducing the delivery of neutrophils and maintaining the wound in an inflammatory phase (Packer et al, 2023)

Hyperglycaemia and other metabolic irregularities	These can diminish immunological function, impede wound healing and lead to excessive collagen cross-linking (Packer et al, 2023)

Assessment and management

Taking a comprehensive history is vital in the care of patients with a DFU. This should encompass the duration of diabetes, the identification of risk factors (Table 3), and a thorough patient history relating to footwear and foot care.

Procedure

Classification

1. Obtain consent

2. Enquire about the patient's age and the duration of their diabetes

3. Gather a full patient history, including any previous ulceration, lower extremity amputation and claudication

4. Verify glycaemic status and HbA1c results

5. Ask the patient about their skin health and their measures for maintaining skin integrity (Mitchell, 2022). Discuss the patient's bathing routines, the various soaps used and whether any products cause skin irritation

6. Review the patient's current medication, past medical history and any chronic medical conditions or comorbidities

7. Assess nutritional status, weight and body mass index. Use the Malnutrition Universal Screening Tool (MUST) (British Association of Parenteral and Enteral Nutrition, 2020) for nutritional screening

8. Confirm any known allergies the patient may have

9. Evaluate the patient's current footwear and discuss footwear behaviours, such as walking barefoot and the fit of shoes (Schaper et al, 2020)

10. Assess patient mobility. Ulcers are most common in weight-bearing areas, including the plantar metatarsal head, heel, tips of hammer toes, and other prominent areas

11. Check for signs of ischaemia:

Ask if the patient experiences any foot pain or numbness

Ascertain whether pedal pulses are present or absent

If the ankle-brachial pressure index (ABPI) score is <0.5 and/or the toe systolic blood pressure (TBP) is <30 mmHg following an ABPI assessment, refer urgently to a specialist clinician (Wounds UK, 2020). Use the IWGDF (Schaper et al, 2023) Ischaemia grading system to score the level of ischaemia. Examine the foot pulses and the pedal Doppler waveforms in combination with the ABPI and toe-brachial index (TBI) to identify the presence of peripheral arterial disease (PAD) (Schaper et al, 2023)

Observe for early signs of PAD including the presence of reduced peripheral hair, shiny, thin skin, hair loss, thickened toenails, reduced or absent pulses and signs of intermittent claudication. ABPI assessment is considered to be unreliable in patients with vascular stiffness and can fail to detect early phases of arteriosclerotic development (Høyer et al, 2013). TBI is the method of choice for evaluating lower limb perfusion disorders, as the toe vessels are less susceptible to vessel stiffness. TBI is an accurate and reliable tool for detecting stenosis in PAD, associated with normal or low ABPI values (Park et al, 2012)

Ask the patient about any sudden onset of a cold, pale, painful limb and examine for the absence of pulses.

12. Assess for signs of neuropathy:

Ask the patient about any foot numbness, tingling or pain

Assess the patient's coordination for any changes or loss

Enquire about burning or shooting pain that might intensify at night

Ask the patient about numbness or loss of sensation, muscle twitching, or cramps.

13. Consider monofilament testing to assess the loss of protective sensations in the foot. Monofilaments are single-fibre nylon thread that generate a buckling stress; the higher the value or weight of the thread, the harder it is to bend. In normal practice a 10g monofilament is used at various points on the plantar aspect of the foot. The patient is assessed with their eyes closed or head turned so that cannot see where the monofilament is being placed. They are to tell the clinician when they feel their foot being touched. A lack of response needs to be checked but will denote a lack of sensation and the protective function. If there is any sign of redness, swelling, increased pain or any other sign of infection, use a wound swab to send for microbiological analysis. This will help to identify the pathogen responsible for the infection and guide appropriate antibiotic therapy. The wound swab should be taken after cleansing the wound to avoid contamination from colonising bacteria on the wound surface (Wounds UK, 2020)

14. Assess the presence or absence of pain. Any type of wound pain may indicate infection, underlying tissue destruction, neuropathy or vascular insufficiency (Hess, 2019). Ask the patient if they are experiencing any pain and whether the pain affects their quality of life. The National Institute for Health and Care Excellence (NICE) (2019) recommends the use of a valid pain tool for assessment

Wound assessment

15. Assess the wound bed using the Tissue management/Infection or inflammation/Moisture balance/Epithelial advancement (TIME) clinical decision support tool (Table 4)

16. Grade the wound using the IWGDF (Schaper et al, 2023) grading system (Table 5). No ulcer or gangrene scores 0 or minor tissue loss on the system, whereas extensive skin loss or a deep ulcer involving the foot midfoot or heel or extensive gangrene scores a 3. Use the Site/Ischemia/Neuropathy, Bacterial infection/Area/Depth (SINBAD) system to grade the ulcer (Schaper et al, 2023)

17. An increase in wound depth heightens the risk of infection. The Infectious Diseases Society of America (IDSA)/IWGDF system can grade infection severity, from uninfected to severe (Table 6) (Senneville et al, 2023). Evidence suggests that the presence of infection and peripheral artery disease in a person with diabetics and an ulcer can result in poor healing outcomes, or amputation (Schaper et al, 2023)

18. Consider the frequency of reassessment and redressing. This should be based on a risk assessment (Table 7)

19. The dressing selection should be based on a full wound assessment and characteristics of the DFU. This includes wound site, wound bed composition, the size and depth of the wound, exudate levels and consistency, and any signs of infection (Wounds UK, 2020). NICE (2019) and Wounds UK (2020) and best practice guidelines suggest dressings with Technology Lipido-Colloid–Nano-Oligo Saccharide Factor to promote wound progression of DFU. All prescribing decisions should be made based on the following considerations: costs, clinical evidence, impact on quality of life, and local clinical pathways (Wounds UK, 2020).

Table 4

Tissue management (T)	Is the wound showing signs of regeneration and repair, such as granulation tissue or epithelial cells, or is the wound bed displaying non-viable tissue for example slough, necrosis or eschar? Assess the amount of non-viable or devitalised tissue	Measure the size of the wound and identify wound depthConsider debridement optionsAssess the extent of tissue involvement, ie epidermis, dermis, fat and fascia. Is there exposed muscle or bone?Assess wound for odour; necrotic wounds are often malodourousReduce the necrotic tissue burdenRestore viable wound bed with functional extracellular matrix
Infection or inflammation (I)	Inflammation (or the inflammatory response) is a normal stage of wound healing. If the wound is red, hot, swollen or painful within the first 1–7 days of injury occurring, then this is a normal inflammatory response and unless the wound is physically dirty it is not likely to be infected	Assess for the presence of biofilm – a polysaccharide matrix made up of micro-organisms that delays wound healing and cause chronic inflammationRestore bacterial balance in the woundRecognise signs of critical colonisation and invasive infectionApply topical antimicrobial dressings. Based on a systematic review, Dumville et al (2017) suggest that the use of antimicrobial dressings instead of non-

		antimicrobial dressing may increase the number of diabetic foot ulcers healed. This may be used as an adjunct to wound healingUse topical antiseptic solutions or systemic antibiotics, if indicated
Moisture balance (M)	A moist wound bed improves healing and reduces pain, discomfort and infection (Winter, 1962). Large amounts of exudate can indicate infection or unmanaged oedema leading to maceration of the wound edges. A dry wound inhibits cellular activities and promotes eschar formation	Assess exudate for type, colour, amount, odour and viscosityAchieve moisture balance for optimum wound healing to stimulate growth factors, cytokines and proliferationConsider dressing type to manage moisture, ie retentive or absorbentConsider systemic therapies to reduce oedema and control inflammationLower limb elevation and compression dressings may be indicated to manage oedema, if sufficient arterial supply measured by toe-brachial index and ankle-brachial pressure index readings indicate (Atkin et al, 2018)

Epithelial advancement (E)	Wound margins tend to change in appearance as a wound heals or deteriorates (Wilson, 2012). Tissue necrosis acts a as a physical barrier to the wound	Assess for calluses of hyperkeratosis at the wound bedPromote migration of epithelial wound edges for contraction and restoration of skin integrity. Remove necrotic tissue, callus and hyperkeratosis Suppress hyper granulation.

Table 5

Category	Definition	Score
Site	Forefoot	0
	Midfoot and hindfoot	1
Ischemia	Pedal blood flow intact (at	0

Category	Definition	Score
	least one pedal	
	pulse can be felt) Clinical evidence of reduced pedal flow	1
Neuropathy	Protective sensation intact	0
	Protective sensation lost	1
	None	0

Category	Definition	Score
Bacterial infection	Present	1
Area of ulcer	Ulcer <1 cm	0
	Ulcer >1 cm	1
Depth	Under confined skin and subcutaneous tissue	0
	Under reaching muscle, tendon, or deeper	1

Category	Definition	Score
Total possible score		0-6

Table 6

Clinical manifestations	Infection severity	PEDIS grade
No signs of inflammation or wound purulence	No infection	1
Presence of two of the following: • Purulence discharge (thick, opaque to white or sanguineous secretion)	Mild	2

Clinical manifestations	Infection severity	PEDIS grade
• Local tenderness, warmth, or induration. • Cellulitis/erythema <2cm, which extends around the ulcer and other local signs of systemic illness		
Patient is systemically well but has more than one of the following: • Cellulitis extending >2cm • Lymphatic streaking (dark streaks extending from the site of the injury) • Swelling, pain and warmth	Moderate	3

Clinical manifestations	Infection severity	PEDIS grade
• Deep tissue abscess, involvement of muscle-tendon or bone		
Patient with systemic toxicity or metabolic instability, for example: • Fever • Chills • Hypotension • Vomiting • Confusion • Temperature >38C or <36C • Respiratory rate of 20 breaths/min.	Severe	4

Table 7

Risk	Reassessment frequency
Patients with an active diabetic foot ulcer (DFU)	Every 1–2 weeks
Patients at a high risk of DFU, previous history of ulceration or identified risk factors	Every 1–2 months
Patients with one	Every 3–6 months

Risk	Reassessment frequency
established risk factor	
Patients identified as having low risk with no symptoms apart from callus alone	Annually

Patient education and ongoing care

20. Take the time to discuss the patient's lifestyle, including their diet, exercise habits, footwear and foot care routines. This will help identify any areas that need to be addressed to promote wound healing and prevent further foot ulcers

21. Provide patient education on the importance of good foot care, including checking the feet daily for any changes, wearing suitable footwear, maintaining good foot hygiene, managing blood sugar levels and quitting smoking

22. Once the ulcer is noticed, refer to podiatry immediately. NICE (2019) recommends that all people newly presenting with DFUs should be referred to a specialist within 1 working day. Also, consider referral if the patient has severe or recurring foot ulcers, or if the patient has significant risk factors for foot complications

23. Keep a close eye on the patient's progress. Regular follow-up appointments will help to ensure that the treatment plan is working and can be adjusted as needed

24. Involve a multidisciplinary team in the care of the patient. This team may include a diabetologist, a podiatrist, a wound care nurse, a vascular surgeon, an orthopaedic surgeon and a dietitian. This team approach can help to ensure that all aspects of the patient's health are addressed, and that the patient receives the best possible care. Standardising communication between healthcare professionals about the severity of the DFU can greatly improve assessment and follow-up treatment (Schaper et al, 2023)

25. Remember the importance of psychosocial support. Living with a chronic disease like diabetes, and dealing with complications such as foot ulcers, can be stressful and emotionally challenging. Providing emotional support and referring the patient to mental health services, if needed, is an important part of holistic care. The management of DFU is complex and requires a comprehensive, multidisciplinary approach. Understanding and addressing the underlying risk factors, providing wound care, promoting good foot care practices, and addressing any barriers to care are all essential components of managing DFUs

26. Discuss self-care and self-management plans including symptom management. Ensure that the patient is aware of support services and how to access these. Discuss red flags, changes in condition and when to contact health services if there is a deterioration or change in symptoms (Box 1)

27. Check that the patient understands the plan of care and what will happen next. Give the patient an opportunity to ask any questions before finishing the assessment

28. Document all findings.

Box 1.Red flags (Wounds UK, 2020)Increased unilateral redness, swelling, pain, pus and heat: these are signs of an infection that may be worsening and could require more aggressive treatment or interventionSepsis symptoms: these may include fever, increased heart rate, difficulty breathing, low blood pressure and mental confusion. Sepsis is a life-threatening condition that requires immediate medical attentionSigns of acute ischaemia: these can include sudden onset of pain, paleness or coldness in the limb, absence of pulse or any rapid change in the condition of the limb. Acute ischaemia is a medical emergency and requires urgent treatment to restore blood flowSuspected acute deep vein thrombosis (DVT): symptoms can include pain, swelling, redness, or a heavy ache in the affected area, typically in the leg. If a DVT is suspected, immediate medical attention is needed as the clot could travel to the lungs and cause a potentially fatal pulmonary embolismSuspected skin cancer: look out for a new growth, a sore that does not heal, or a change in an existing skin lesion. Any suspicion of skin cancer should be promptly evaluated by a healthcare providerIn the presence of these red flags, prompt referral and treatment are vital to prevent further complications.

Conclusions

All assessment, care and management of a DFU should be planned and agreed upon with the patient. It is essential that healthcare professionals work collaboratively with patients and specialist services to ensure the best outcomes. Early identification of risk factors and measures put into place to mitigate these factors can lead to improved patient outcomes and quality of care.

References

NICE guidelines. 2020. https://www.nice.org.uk/ about/whatwe-do/ourprogrammes/nice-guidance/ antimicrobialprescribing-guidelines (accessed

29 January 2024)

National Institute for Health and Care Excellence. Leg ulcer—venous. 2020.

https://cks.nice.org.uk/leg-ulcervenous (accessed 29 January 2024)

Ndip A, Lavery L, Boulton A. Diabetic foot disease in people with advanced

nephropathy and those on renal dialysis. Curr Diab Rep.2010;10(4):283–290.

https://doi.org/10.1007/s11892-010-0128-0

Ouyang W, Jia Y, Lingli J. Risk factors of diabetic foot ulcer in patients with type

2 diabetes: a retrospective cohort study. J Foot Ankle Res. 2021;16:18. http://

doi.org/10.1186/s13047-023-00616-0

Packer C, Awab A, Mana B. Diabetic ulcer. 2023. https://www.ncbi.nlm.nih.

gov/books/NBK499887/ (accessed 29 January 2024)

Park S, Choi C, Ha YI, Yang H. Utility of toe-brachial index for diagnosis of

peripheral arterial disease. Arch Plast Surg. 2012;39(3):227–231. https://doi.

org/10.5999/aps.2012.39.3.227

Schaper NC, van Netten JJ, Apelqvist J et al. Practical guidelines on the

prevention and management of diabetic foot disease (IWGDF 2019

update). Diabetes Metab Res Rev. 2020;36(S1) Suppl 1:e3266. https://doi.org/10.1002/dmrr.3266

Schaper NC, van Netten JJ, Apelqvist J et al. IWGDF guidelines on the prevention and management of diabetic-related foot disease. 2023. https://iwgdfguidelines.org/wp-content/uploads/2023/07/IWGDFGuidelines-2023.pdf (accessed 2 February 2024)

Senneville E, Alabalawi Z, van Asten SA et al. IWGDF/IDSA guidelines on the diagnosis and treatment of diabetes-related foot infections (IWGDF/IDSA 2023). Clinical Infectious Diseases. 2023;ciad527. https://doi.org/10.1093/cid/ciad527

Tatulashvili S, Fagherazzi G, Dow C, Cohen R, Fosse S, Bihan H. Socioeconomic inequalities and type 2 diabetes complications: a systematic review. Diabetes Metab.2020;46(2):89–99. https://doi.org/10.1016/j.diabet.2019.11.001

Wilson M. Understanding the basics of wound assessment. Wound Essentials. 2012;7(2):8–12

Winter GD. Formation of the scab and the rate of epithelization of superficial wounds in the skin of the young domestic pig. Nature. 1962;193(4812):293–294. https://doi.org/10.1038/193293a0

Wounds UK. Quick guide: times model of wound bed preparation. 2017. https://wounds-uk.com/quick-guides/quick-guide-times-model-of-woundbed-preparation/ (accessed 2 February 2024)

Wounds UK. Best practice statement: antimicrobial stewardship strategies for wound management. 2020. https://wounds-uk.com/best-practicestatements/best-practice-statement-antimicrobial-stewardship-strategieswound-management/ (accessed 29 January 2024)

Yotsu R, Pham N, Oe M et al. Comparison of characteristics and healing course of diabetic foot ulcers by etiological classification: neuropathic, ischemic, and neuro-ischemic type. J Diabetes Complications.2014;28(4):528–535. https://doi.org/10.1016/j.jdiacomp.2014.03.013

Zhang GQ, Canner JK, Kayssi A, Abularrage CJ, Hicks CW. Geographical socioeconomic disadvantage is associated with adverse outcomes following major amputation in diabetic patients. J Vasc Surg. 2021;74(4):1317–1326.e1. https://doi.org/10.1016/j.jvs.2021.03.033

Zhang P, Lu J, Jing Y, Tang S, Zhu D, Bi Y. Global epidemiology of diabetic foot ulceration: a systematic review and meta-analysis. Ann Med. 2017;49(2):106–116. https://doi.org/10.1080/07853890.2016.1231932