

WORLD UNION
OF
WOUND HEALING SOCIETIES



WORLD UNION OF WOUND HEALING SOCIETIES
POSITION DOCUMENT

LOCAL MANAGEMENT OF DIABETIC FOOT ULCERS

**Innovations in the management of DFUs
and the diabetic foot in remission**

**Living with a DFU: the patient's
perspective**

Managing and treating DFUs



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Incidence of diabetes among the world's adult population has almost quadrupled in the past 30 years with 422 million adults worldwide now diagnosed with the disease, according to the 2016 World Health Organization Global Diabetes Report. Within this population, the incidence of diabetic foot ulcers (DFUs) is reported to be 4%–10%, with a 1-in-4 risk of ulceration during a lifetime.

The financial and human cost of the disease and associated complications are high: the American Diabetes Association puts the global direct costs of the disease at \$825bn. The cost of the lower limb extremity accounts for a significant proportion of this spend — in the US alone the cost of care of DFUs ranges from \$9bn to \$13bn of which between \$1.38bn and \$1.9bn is spent on diabetic infection alone.

Increased incidence and escalating costs are having a devastating impact on health services and putting further pressure on resources. Central to tackling the growing problem is the implementation of robust prevention strategies that look to reduce DFU incidence. This Position Document looks at the local management of DFUs against a backdrop of increased incidence, stretched resources and patient outcomes.

Paper 1 'Innovations in the management of DFUs and the diabetic foot in remission' sets the global scene, looking at classification of DFUs, prevention strategies and the growing importance of multidisciplinary teams (MDTs) in the management and treatment of them. A coordinated team is pivotal to improving outcomes and has already been shown to decrease frequency of limb loss. Yet MDTs are still in their infancy; there are currently no established parameters for these teams. Despite guidelines from the International Working Group on the Diabetic Foot, the composition of MDTs is dependent upon availability of local resources, skill mix and scope.

Paper 2 'Living with a DFU: the patient's perspective' looks at what it is like to have a DFU with a detailed look at wellbeing. It explores the importance of consultation in addressing, managing and treating not just physical effects but in developing a patient-focused, personalised care plan that tackles the psychosocial impact of DFUs. In particular it looks at the role of dressings that must meet patients' needs (e.g. preventing leakage, reducing malodour) as well as the clinician's need to ensure optimal healing.

The final paper 'Managing and treating DFUs' was developed from a meeting of leading experts in DFUs, it drills down into the principles of local management, with a detailed look at dressing use; the management of exudate levels, deep wounds, infected wounds, prevention of periwound damage and pain. It also looks at the use of second-line (advanced) topical treatments and the role of self care.

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Innovations in the management of DFUs and the diabetic foot in remission

The aim of this paper is to provide an overview of the extent of the problem now faced in treating diabetic foot ulcers (DFUs); what makes these wounds so complex and the evolution of advanced dressings to improve patient outcomes. In order to promote optimal wound healing and to reduce the impact of chronic wounds on the health economy, clinicians need tools and education that facilitate accurate and comprehensive wound assessment and evidence-based wound management.

EPIDEMIOLOGY: GLOBAL FACTS AND FIGURES

In the past 30 years the incidence of diabetes among the world's adult population has nearly quadrupled, rising to over 422 million adults worldwide. During this time global prevalence has increased from 4.7% to 8.5%^[1]. Within the diabetic population, the incidence of DFUs has been reported to be 4%–10%, with a 1-in-4 risk of ulceration during an individual's lifetime^[2,3].

Individuals with DFUs are demonstrating increased incidence of hospitalisation due to infection, which has resulted in a rise in the number of amputations^[4,5,6,7]. Of all amputations associated with a foot wound of any type, DFUs precede up to 83% of major and 96% minor amputations^[7-11]. Furthermore it has been reported that 55% of individuals with diabetes and a lower extremity amputation will require further amputation in less than 3 years^[12,13].

The mortality rate of diabetes and diabetes-related complications is greater than the 5-year mortality rate of breast, colon and prostate cancer combined^[14]. In 2012 alone approximately 3.7 million deaths were related directly to diabetes and associated complications^[15]. The culmination of these findings marks the first time in the history of humanity that deaths from non-communicable diseases have surpassed those from contagions^[16].

COST OF DIABETES AND CARING FOR DFUs

Diabetes is now associated with an astonishing \$825bn in direct costs of care, worldwide. Even more remarkable is that over one-quarter of these costs stems from one nation alone — the US^[15,16]. The cost of care of the lower extremity constitutes a significant proportion of this budget. In the US, the cost of diabetic foot infection alone is between \$1.38bn and \$1.9bn, while the annual cost of care of DFUs ranges between \$9bn and \$13bn^[5,7,18]. This does not take into account care of vascular disease in the extremity, which frequently coexists.

The total cost of diabetic inpatient care for foot ulcerations is significant and if they result in admission can be upwards of \$100,000^[6,19]. It has been reported that as much as 25%–50% of all costs related to inpatient care among the diabetic population can be directly attributed to DFUs^[20].

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“...[this] marks the first time in the history of humanity that deaths from non-communicable diseases have surpassed those from contagions^[16]”

In terms of foot wounds, DFUs are the foremost cause of hospital admission with increasing incidence of wound infection on initial presentation over the past 5 years. This has also been associated with an up to 10-fold increase in cost^[7].

Treatment costs for DFUs vary dramatically across the globe. The cost of care is highest in the US in almost all areas of treatment. In the US, approximately two-thirds of costs related to diabetes care are provided by government insurance; around one-third by private insurance and a small percentage (3.2%) paid without insurance^[16]. Total charges, when compared to patient income, also vary; there is often an inverse relationship between total cost and patient income. In many countries the total cost for DFU care is disproportionately prohibitive when compared to patient income^[21]. In fact the cost of treatment for DFUs can range from three months salary to more than six years worth of income depending on the geographic region and severity of disease^[21].

Direct medical costs associated with complications of diabetes, including DFUs, present substantial indirect economic loss to patients, their families and society through lost income, disability and decreased societal contributions^[16]. Absenteeism and reduced productivity at work create indirect costs of approximately \$26bn for the employed population. Further reports on reduced productivity and disability due to disease total more than \$23bn. Other reports have put the total indirect costs due to early mortality at \$20bn. These findings put the total annual cost of diabetes, diabetic foot wounds (\$175bn) and indirect costs (\$70bn) in the US at over \$245bn annually^[16].

HOLISTIC APPROACH TO MANAGEMENT

The diabetic foot wound often poses a complex clinical picture that may be initially difficult to address. A systematic approach to the management of a DFU requires understanding of its multiple confounding factors and aetiologies. Sound knowledge of appropriate examination procedures, therapeutic modalities or an established pathway for referral is vital for effective holistic management of DFUs.

CLASSIFICATION OF DFUs

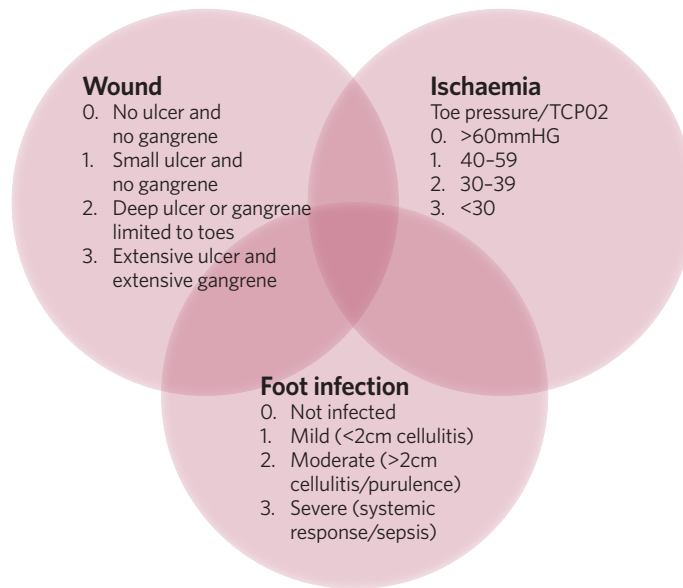
To ensure holistic assessment and treatment of DFUs, the wound should be classified according to a validated clinical tool (Frykberg and Banks, 2015)^[22].

The SINBAD (site, ischaemia, neuropathy, bacterial infection and depth) framework uses a scoring system that helps predict outcomes, and is a simplified version of a previous classification system; however, although it is comprehensive and attempts to be useful across geographies, SINBAD is not well established in literature^[23]. Developed in 2012, the PEDIS is similarly not well established and there are few categories for classification, however it is user-friendly and can be used by clinicians not as experienced in managing DFUs^[23].

There are two well-established classifications. The first is the Wagner scale, which assesses ulcer depth together with presence of gangrene and loss of perfusion over six grades (0–5); however, it does not fully take into account infection and ischaemia^[23]. The University of Texas scale may be the most well received, as it accounts for all aspects of assessment and cross-references them against one another, to devise a two-part score that includes grade and stage^[23]. Thus it lets the clinician gain a complete picture of the individual wound.

More recently, a new classification system of ‘the threatened lower limb’ — WIfI (Wound, Ischaemia, foot, Infection; Figure 1, page 6) — has been developed for use in diabetic and non-diabetic patients^[24]. This system has been adopted by the Society for Vascular Surgery and has been validated in rapid succession by multiple investigators^[24–27].

Figure 1 | Structure of the Wound/Ischaemia/foot Infection (WIFI) system^[26]



Clinicians should be aware of three key aetiologies that will influence assessment, treatment of the underlying condition and management of the DFU:

- Neuropathy
- Ischaemia
- Neuroischaemia.

Neuropathy and peripheral artery disease (PAD), along with cardiovascular disease, renal dysfunction and others, are well known comorbidities of diabetes. Specialists involved in healing diabetic foot ulceration recognise the importance of perfusion, offloading and proper monitoring. However, when ulceration is present, appropriate classification and treatment strategies of each wound’s characteristic must be considered for adequate and timely treatment by appropriately trained physicians^[28].

A clinically verified, holistic approach to DFUs, such as WIFI^[26], outlines three areas that need to be addressed and helps to identify which, at any one time, is the most ‘dominant’ risk:

1. Tissue loss
2. Ischaemia
3. Infection^[25,27,29].

Stemming tissue loss: All patients ranging from those with solely diabetic neuropathy to those with neuropathy, PAD and infection share a single common denominator: tissue loss. The primary pillars in wound care are to decrease non-viable tissue, promote healthy tissue growth and prevent soft tissue loss^[30,31].

The healing of soft tissue deficit follows a natural progression, which should be considered when evaluating appropriate wound management. The base of a wound must first be filled with healthy granulation tissue before the most superficial epithelialisation can occur.

The initial or ‘vertical phase’ produces sufficient wound bulking, coverage of vital structures and depth resolution to allow further advancement of epithelialisation. In the ‘horizontal’ phase of wound healing, natural cellular signalling optimises the physical and physiologic state of a wound for the horizontal migration of epithelial cells to the wound centre. Although there are certain areas of phasic overlap, this ‘vertical-then-horizontal’ progression provides basic understanding to the order and expectation of results in wound therapies and healing.

“As the risk of complications from diabetes heightens, the role of the GP is paramount in providing early referrals to specialist care”

Managing ischaemia: Prevalence of PAD in the diabetic population is between 10% and 40%. Recent estimates show PAD is a complicating factor in the management of nearly 65% of all DFUs^[32]. Furthermore, patients with peripheral neuropathy and PAD have higher re-ulceration and amputation rates than those with peripheral neuropathy alone^[33]. Appropriate vascular evaluation and strategy formulation to ameliorate or monitor the effects of ischaemia must be used to aid wound healing in all patients presenting with a diabetic foot ulceration^[34].

Eradicating infection: Infection is the driving force towards amputation in diabetic foot wounds even in the presence of ischaemia. Often patients presenting with severe infection require emergency surgical intervention. Where this is not appropriate, IDSA guidelines on antibiotic treatment of diabetic foot infections should be followed^[35]. It is important to identify pathogens and the susceptibility profile from appropriate culture methods, including deep tissue samples^[36,37]. In severe, yet non-surgical or complicated soft tissue infections, referral to infectious disease (ID) specialists may be necessary to ensure active ID involvement is included in the care plan.

The first step in wound treatment is thorough, routine cleansing, this includes removing all surface debris, slough and infected tissue; areas of necrosis should be debrided to the point of clean and healthy tissue^[38]. There is general paucity of studies justifying serial sharp debridement, however most international and proprietary healthcare guidelines for wound care support the practice. One review on wound treatment revealed vigorous sharp wound debridement was more likely to produce healing at 12 weeks than other interventions^[39]. It has also been noted that patients who received frequent debridement experienced increased rates of healing^[40]. Further investigation into the correlation of debridement and improved wound healing suggests benefits associated with serial debridement of DFUs^[41]. (For further details on debridement, turn to page 21.)

PREVENTION STRATEGIES

All too often an initial discussion with a patient concerning his/her diabetic foot wound happens in the emergency department, and centres on imminent acute surgical intervention. Increasing the level of GP involvement in diabetic foot care can help to reduce the number of times patients present to emergency departments.

As the risk of complications from diabetes heightens, the role of the GP is paramount in providing early referrals to specialist care, as well as initiating the direction intervention should take. Research reveals that GPs often have insufficient instruction in diabetic foot care, and that regular comprehensive foot exams on patients with diabetes are infrequent^[42-44].

Wound healing specialists are at the forefront of providing vital information concerning the diabetic foot among peer physicians. Critical points of discussion include:

- Reviewing the 3-minute foot exam^[45] while promoting its utility in every patient with diabetes
- Summarising the American Diabetes Association (ADA) guidelines for primary care physicians, the ADA Comprehensive Foot Examination and Risk Assessment guidelines
- Promoting an approach to the care of DFUs when discussing appropriate referrals for specialist care^[3,45].

Secondary prevention of DFUs is backed by strong data. Research over the past generation has consistently pointed to pressure relief strategies and use of inflammation-identifying tools such as thermometry to identify and reduce risk of re-ulceration in patients in diabetic foot remission^[44,46,47,48].

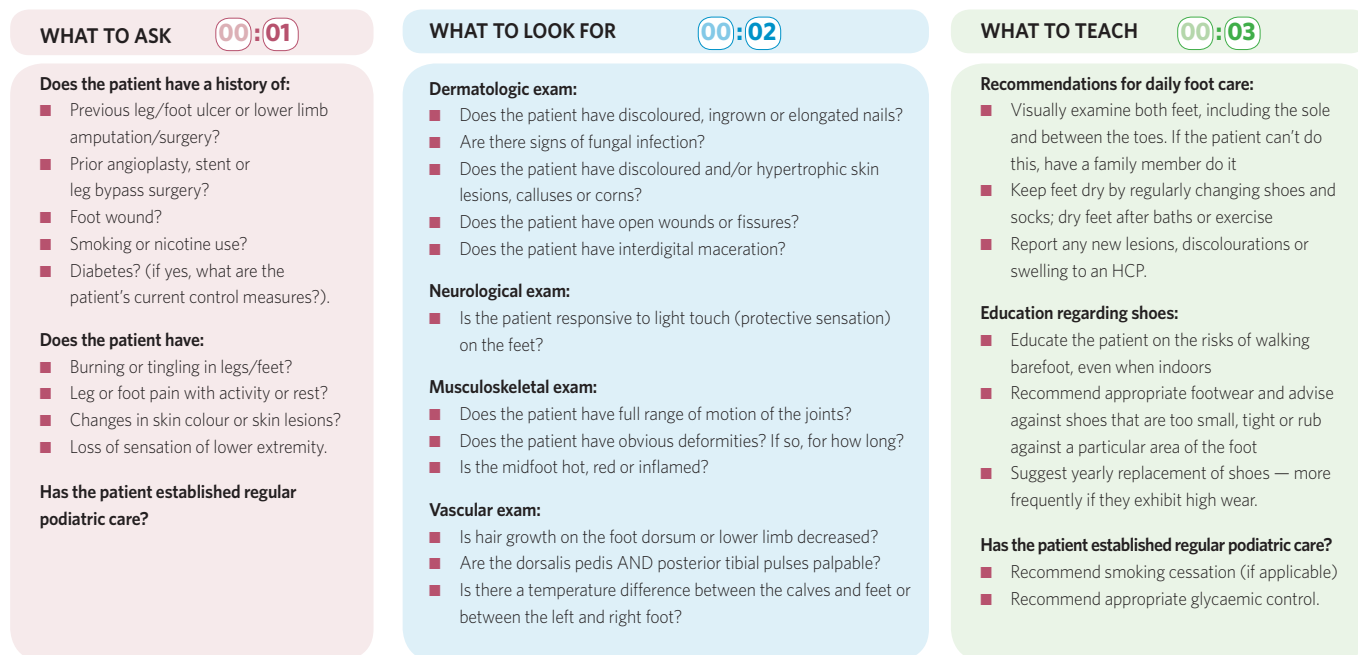


Figure 2 | 3-minute diabetic foot exam^[45]

MULTIDISCIPLINARY APPROACH TO CARE

Diabetes is a complex disease and the management of DFUs requires input from a wide range of clinical specialties. A multidisciplinary team (MDT) approach to DFUs is key to understanding the linear relationship between uncontrolled diabetes, vascular compromise, foot deformity, diabetic foot infection and other comorbidities. The burden of care and spectrum of services required for sustainable success in diabetic foot care requires a team of organised and unified specialists.

A team effort, along with a systemic approach towards controlling ischaemia, wound severity, and foot infection will help reduce the risk of amputation and identify the ever-changing dominant risk factors during the lifetime of the patient's care^[49,50].

Early referral to an expert MDT is likely to improve outcomes. A recent audit of diabetes foot care in England and Wales found that patients who were assessed by experts within two weeks were more likely to be free of foot ulcers at 12 weeks than patients who had to wait longer to be seen^[51].

A coordinated team approach has also been shown to decrease the frequency of limb loss in diabetic patients worldwide^[52-54]. In the Netherlands, and recently the US, the inclusion of podiatrists in a multidisciplinary approach to diabetic foot disease has reduced amputations by 34% and 64%, respectively^[55,56]. Asian healthcare teams report strong correlation between teamwork and multidisciplinary protocol in diabetic foot care in reducing rates of amputation^[57,58].

In the UK, an organised MDT approach to the diabetic foot has shown sustained reduction in amputation rates^[59,60]. Italian literature also reports a reduction in hospitalisation and major limb amputation thanks to deployment of an MDT in high-risk patients^[61]. While there is a significant amount of data to show that multidisciplinary protocol and teamwork reduce amputations, as yet, there is no data to show definitively that a combination of advanced therapies and care via an MDT leads to shorter healing times.

The benefits of an MDT are far reaching, including a focused approach to each patient's particular needs, optimised multifaceted management of patients with diabetes, and enhanced patient surveillance^[62]. When considering the makeup of an MDT there is no established set of parameters. The IDF recommends that in order to provide comprehensive specialist foot care an MDT should comprise doctors with a particular interest in diabetes, diabetes podiatrists, trained nurses, vascular

Table 1 | Time for a specialist? Mapping out a treatment and follow-up plan

Priority	Indications	Timeline	Suggested follow up
Urgent (active pathology)	Open wound or ulcerative area with or without signs of infection New neuropathic pain or pain at rest Signs of active Charcot deformity (red, hot, swollen midfoot or ankle) Vascular compromise (sudden absence of DT/PT pulses or gangrene)	Immediate referral/consult	As determined by specialist
High (ADA risk category 3)	Presence of diabetes with a previous history of ulcer or lower extremity amputation Chronic venous insufficiency (skin colour change or temperature difference)	Immediate or 'next available' outpatient referral	Every 1-2 months
Moderate (ADA risk category 2)	Peripheral artery disease +/- LOPS DP/PT pulse diminished or absent Presence of swelling or oedema	Referral within 1-3 weeks (if not already receiving regular care)	Every 2-3 months
Low (ADA risk category 1)	LOPS +/- longstanding, non-changing deformity Patient requires prescriptive or accommodative footwear	Referral within 1 month	Every 4-6 months
Very low (ADA risk category 0)	No LOPS or peripheral artery disease Patient seeks education regarding foot care, athletic training, appropriate footwear, preventing injury, etc	Referral within 1-3 months	Annually as a minimum

*All patients with diabetes should be seen at least once a year by a foot specialist.
Key: ADA = American Diabetes Association; DP = dorsalis pedis; LOPS = loss of protective sensation; PT = posterior tibial

surgeons, orthopaedic surgeons, infection specialists, orthotists, social workers and psychologists. However, despite the guidelines, it is local resources that will govern the skill mix and scope of any foot care team. The key within any team is the ability to access immediately relevant healthcare professionals, e.g. a vascular surgeon.

In the UK there have been moves towards establishing a core team of specialist diabetes podiatrists, medical specialty consultants, orthotists and surgeons working with nurses and GPs in a 'virtual' network. In many countries there is a shortage of specialist practitioners, which makes establishing an MDT extremely difficult. However, non-specialist practitioners can play a key role in the early detection of problems and prompt referrals.

Ideally, one clinician should act as coordinator (or gatekeeper) of multidisciplinary care to ensure that appropriate referrals are made and that care is integrated. The coordinator may be a podiatrist, a surgeon or another type of clinician with a special interest in diabetes. In some countries, coordinated care may be based within a single clinic^[63].

SUMMARY

DFUs are complex and costly to patients and health systems alike. As diabetic foot syndrome incorporates endocrine, histologic, neurologic, ischaemic and orthopaedic factors, it is important that DFU assessment is holistic and multidisciplinary, with a focus not only on evaluating and managing the wound, but diagnosing and treating underlying disease.

As yet there is no universal model of care, nor indeed is any one nation leading the way in terms of significantly reducing healing times.

The chances that these wounds will heal spontaneously are limited because the underlying systemic disease — diabetes mellitus — impairs the process of normal wound healing. However, by adopting a holistic approach to wound healing, with appropriate referrals and multidisciplinary involvement, DFUs can be healed and limbs saved^[22].

REFERENCES

1. Anon. 2016. *Global Report on Diabetes*. World Health Organization. Available at: http://apps.who.int/iris/bitstream/10665/204871/1/9789241565257_eng.pdf. (accessed May 17, 2016)
2. Singh N, Armstrong DG, Lipsky BA. Preventing foot ulcers in patients with diabetes. *JAMA* 2005 Jan 12; 293(2):217-28.
3. Boulton AJ, Armstrong DG, Albert SF, Frykberg RG, Hellman R, Kirkman MS, Lavery LA, LeMaster JW, Mills JL, Mueller MJ, Sheehan P. Comprehensive foot examination and risk assessment: a report of the task force of the foot care interest group of the American diabetes association, with endorsement by the American association of clinical endocrinologists. *Diabetes care* 2008 Aug 1; 31(8):1679-85.
4. Skrepnek GH, Mills JL, Armstrong DG. Foot-in-Wallet Disease: Tripped Up by "Cost-Saving" Reductions? *Diabetes Care* 2014 Sep 1; 37(9):e196-7.
5. Skrepnek GH, Mills Sr JL, Armstrong DG. A Diabetic Emergency One Million Feet Long: Disparities and Burdens of Illness among Diabetic Foot Ulcer Cases within Emergency Departments in the United States, 2006-2010. *PLoS one* 2015 Aug 6; 10(8):e0134914.
6. Skrepnek GH, Armstrong DG, Mills JL. Open bypass and endovascular procedures among diabetic foot ulcer cases in the United States from 2001 to 2010. *Journal of vascular surgery* 2014 Nov 30; 60(5):1255-65. Available at: <http://dx.doi.org/10.1016/j.jvs.2014.04.071>
7. Hicks CW, Selvarajah S, Mathioudakis N, Sherman RE, Hines KF, Black JH, Abularrage CJ. Burden of Infected Diabetic Foot Ulcers on Hospital Admissions and Costs. *Annals of vascular surgery* 2016 May 31; 33:149-58.
8. Boulton AJ. The diabetic foot: grand overview, epidemiology and pathogenesis. *Diabetes/metabolism research and reviews* 2008 May 1; 24(S1):S3-6.
9. Driver VR, Fabbri M, Lavery LA, Gibbons G. The costs of diabetic foot: the economic case for the limb salvage team. *Journal of vascular surgery* 2010 Sep 30; 52(3):175-225.
10. Imperatore G, Cadwell BL, Geiss L, Saadine JB, Williams DE, Ford ES, Thompson TJ, Narayan KV, Gregg EW. Thirty-year Trends in Cardiovascular Risk Factor Levels among US Adults with Diabetes National Health and Nutrition Examination Surveys, 1971-2000. *American journal of epidemiology* 2004 Sep 15; 160(6):531-9.
11. Engelgau MM, Geiss LS, Saadine JB, Boyle JP, Benjamin SM, Gregg EW, Tierney EF, Rios-Burrows N, Mokdad AH, Ford ES, Imperatore G. The evolving diabetes burden in the United States. *Annals of internal medicine* 2004 Jun 1; 140(11):945-50.
12. Pandian G, Hamid F, Hammond M. Rehabilitation of the patient with peripheral vascular disease and diabetic foot problems. *Rehabilitation medicine: principles and practice*. 3rd ed. Philadelphia: Lippincott-Raven 1998; pp1517-44.
13. Armstrong DG, Lavery LA, Harkless LB, Van Houtum WH. Amputation and reamputation of the diabetic foot. *Journal of the American Podiatric Medical Association* 1997 Jun; 87(6):255-9.
14. Robbins JM, Strauss G, Aron D, Long J, Kuba J, Kaplan Y. Mortality rates and diabetic foot ulcers: is it time to communicate mortality risk to patients with diabetic foot ulceration? *Journal of the American Podiatric Medical Association* 2008 Nov; 98(6):489-93.
15. Armstrong DG, Salas P, Short B, Martin BR, Kimbriel HR, Nixon BP, Boulton AJ. Maggot therapy in "lower-extremity hospice" wound care: fewer amputations and more antibiotic-free days. *Journal of the American Podiatric Medical Association* 2005 May; 95(3):254-7.
16. American Diabetes Association. Economic costs of diabetes in the US in 2012. *Diabetes Care* 2013; 36:1033-1046. *Diabetes Care* 2013 Jun; 36(6):1797.
17. Zhou B, Lu Y, Hajifathalian K, Bentham J, Di Cesare M, Danaei G, Bixby H, Cowan MJ, Ali MK, Taddei C, Lo WC. Worldwide trends in diabetes since 1980: pooled analysis of 751 population-based measurement studies with over 4.4 million participants. *The Lancet* 2016 Apr 1.
18. Rice JB, Desai U, Alice Kate G, Cummings BA, Birnbaum HG, Skornicki M, Parsons NB. Burden of diabetic foot ulcers for medicare and private insurers. *Diabetes care* 2014; 37(3), pp.651-658.
19. Kerr M, Rayman G, Jeffcoate WJ. Cost of diabetic foot disease to the National Health Service in England. *Diabetic Medicine* 2014 Dec 1; 31(12):1498-504.
20. Kantor J, Margolis DJ. Treatment Options for Diabetic Neuropathic Foot Ulcers: A Cost-effectiveness Analysis. *Dermatologic Surgery* 2001 Apr 1; 27(4):347-51.
21. Cavanagh P, Attinger C, Abbas Z, Bal A, Rojas N, Xu ZR. Cost of treating diabetic foot ulcers in five different countries. *Diabetes/metabolism research and reviews* 2012 Feb 1; 28(S1):107-11.
22. Frykberg RG, Banks J. Challenges in the treatment of chronic wounds. *Adv Wound Care (New Rochelle)* 2015; 4(9): 560-82.
23. Chadwick P, Edmonds M, McCardle J, Armstrong D. *Best practice guidelines: Wound management in diabetic foot ulcers*. Wounds International 2013. Available at: www.woundsinternational.com
24. Mills JL, Conte MS, Armstrong DG, Pomposelli FB, Schanzer A, Sidawy AN, Andros G, Society for Vascular Surgery Lower Extremity Guidelines Committee. The Society for Vascular Surgery Lower Extremity Threatened Limb Classification System: risk stratification based on wound, ischemia, and foot infection (WIFI). *Journal of vascular surgery* 2013; 59(1), pp.220-34.e1-2.
25. Cull DL, Manos G, Hartley MC, Taylor SM, Langan EM, Eidt JF, Johnson BL. An early validation of the Society for Vascular Surgery lower extremity threatened limb classification system. *Journal of vascular surgery* 2014 Dec 31; 60(6):1535-42.
26. Causey MW, Ahmed A, Wu B, Gasper WJ, Reyzelman A, Vartanian SM, Hiramoto JS, Conte MS. Society for Vascular Surgery limb stage and patient risk correlate with outcomes in an amputation prevention program. *Journal of vascular surgery* 2016 Jun 30; 63(6):1563-73.
27. Zhan LX, Branco BC, Armstrong DG, Mills JL. The Society for Vascular Surgery lower extremity threatened limb classification system based on Wound, Ischemia, and foot Infection (WIFI) correlates with risk of major amputation and time to wound healing. *Journal of vascular surgery* 2015 Apr 30; 61(4):939-44. Available at: <http://dx.doi.org/10.1016/j.jvs.2014.11.045>.
28. Schaper NC, Andros G, Apelqvist J, Bakker K, Lammer J, Lepantalo M, Mills JL, Reekers J, Shearman CP, Zierler RE, Hinchliffe RJ. Diagnosis and treatment of peripheral arterial disease in diabetic patients with a foot ulcer. A progress report of the International Working Group on the Diabetic Foot. *Diabetes/metabolism research and reviews* 2012 Feb 1; 28(S1):218-24.
29. Armstrong DG, Mills JL. Juggling risk to reduce amputations: the three-ring circus of infection, ischemia and tissue loss-dominant conditions. *Wound Medicine* 2013 Jul 31; 1:13-4.
30. Armstrong DG, Mills JL. Toward a change in syntax in diabetic foot care: prevention equals remission. *Journal of the American Podiatric Medical Association* 2013 Mar; 103(2):161-2.
31. Arad Y, Fonseca V, Peters A, Vinik A. Beyond the Monofilament for the Insensate Diabetic Foot A systematic review of randomized trials to prevent the occurrence of plantar foot ulcers in patients with diabetes. *Diabetes care* 2011 Apr 1; 34(4):1041-6.
32. Hinchliffe RJ, Andros G, Apelqvist J, Bakker K, Fiedrichs S, Lammer J, Lepantalo M, Mills JL, Reekers J, Shearman CP, Valk G. A systematic review of the effectiveness of revascularization of the ulcerated foot in patients with diabetes and peripheral arterial disease. *Diabetes/metabolism research and reviews* 2012 Feb 1; 28(S1):218-24.

reviews 2012 Feb 1; 28(S1):179-217.

33. Apelqvist J, Elgzyri T, Larsson J, Löndahl M, Nyberg P, Thörne J. Factors related to outcome of neuroischemic/ischemic foot ulcer in diabetic patients. *Journal of vascular surgery* 2011 Jun 30; 53(6):1582-8.

34. Mills JL, Conte MS, Armstrong DG, Pomposelli FB, Schanzer A, Sidawy AN, Andros G, Society for Vascular Surgery Lower Extremity Guidelines Committee. The Society for Vascular Surgery lower extremity threatened limb classification system: risk stratification based on Wound, Ischemia, and foot Infection (WIFI). *Journal of vascular surgery* 2014 Jan 31; 59(1):220-34. e1-2.

35. Lipsky BA, Berendt AR, Cornia PB, Pile JC, Peters EJ, Armstrong DG, Deery HG, Embil JM, Joseph WS, Karchmer AW, Pinzur MS. 2012 Infectious Diseases Society of America clinical practice guideline for the diagnosis and treatment of diabetic foot infections. *Clinical infectious diseases* 2012 Jun 15; 54(12):e132-73.

36. Sotito A, Richard JL, Combescure C, Jourdan N, Schuldiner S, Bouziges N, Lavigne JP. Beneficial effects of implementing guidelines on microbiology and costs of infected diabetic foot ulcers. *Diabetologia* 2010 Oct 1; 53(10):2249-55.

37. Armstrong DG, Lipsky BA. Advances in the treatment of diabetic foot infections. *Diabetes technology & therapeutics* 2004 Apr 1; 6(2):167-77.

38. Game FL, Apelqvist J, Attinger C, Hartemann A, Hinchliffe RJ, Löndahl M, Price PE, Jeffcoate WJ. IWGDF guidance on use of interventions to enhance the healing of chronic ulcers of the foot in diabetes. *Diabetes/metabolism research and reviews* 2016 Jan 1; 32(S1):75-83.

39. Saap, L.J. & Falanga, V., 2002. Debridement performance index and its correlation with complete closure of diabetic foot ulcers. *Wound repair and regeneration: official publication of the Wound Healing Society [and] the European Tissue Repair Society*, 10(6), pp.354-359.

40. Steed DL, Donohoe D, Webster MW, Lindsley L. Effect of extensive debridement and treatment on the healing of diabetic foot ulcers. Diabetic Ulcer Study Group. *Journal of the American College of Surgeons* 1996 Jul; 183(1):61-4.

41. Cardinal M, Eisenbud DE, Armstrong DG, Zelen C, Driver V, Attinger C, Phillips T, Harding K. Serial surgical debridement: a retrospective study on clinical outcomes in chronic lower extremity wounds. *Wound repair and regeneration* 2009 May 1; 17(3):306-11.

42. Wylie-Rosett J, Walker EA, Shamon H, Engel S, Basch C, Zybert P. Assessment of documented foot examinations for patients with diabetes in inner-city primary care clinics. *Archives of family medicine* 1995 Jan; 4(1):46-50.

43. Del Aguila MA, Reiber GE, Koepsell TD. How does provider and patient awareness of high-risk status for lower-extremity amputation influence foot care practice? *Diabetes care* 1994 Sep 1; 17(9):1050-4.

44. Miller JD, Salloum M, Button A, Giovinco NA, Armstrong DG. How can I maintain my patient with diabetes and history of foot ulcer in remission? *The international journal of lower extremity wounds* 2014 Aug 20; 15(3):145-150.

45. Miller JD, Carter E, Shih J, et al. How to do a 3-minute diabetic foot exam. *J Fam Pract* 2014; 63(11):646-9,653-6.

46. Bus SA. Innovations in plantar pressure and foot temperature measurements in diabetes. *Diabetes/metabolism research and reviews* 2016 Jan 1; 32(S1):221-6.

47. Bus SA, Armstrong DG, Deursen RW, Lewis JE, Caravaggi CF, Cavanagh PR. IWGDF guidance on footwear and offloading interventions to prevent and heal foot ulcers in patients with diabetes. *Diabetes/metabolism research and reviews* 2016 Jan 1; 32(S1):25-36.

48. Armstrong DG, Holtz-Neiderer K, Wendel C, Mohler MJ, Kimbriel HR, Lavery LA. Skin temperature monitoring reduces the risk for diabetic foot ulceration in high-risk patients. *The American journal of medicine* 2007 Dec 31; 120(12):1042-6.

49. Mills JL, Conte MS, Armstrong DG, Pomposelli FB, Schanzer A, Sidawy AN, Andros G, Society for Vascular Surgery Lower Extremity Guidelines Committee. The Society for Vascular Surgery lower extremity threatened limb classification system: risk stratification based on Wound, Ischemia, and foot Infection (WIFI). *Journal of vascular surgery* 2014 Jan 31; 59(1):220-34.

50. Fitzgerald RH, Mills JL, Joseph W, Armstrong DG. The diabetic rapid response acute foot team: 7 essential skills for targeted limb salvage. *Éplasty* 2009 May; 9:e15.

51. National Diabetes Foot Care Audit (NHS) 2016, March.

52. Larsson J, Stenström A, Apelqvist J, Agardh CD. Decreasing incidence of major amputation in diabetic patients: a consequence of a multidisciplinary foot care team approach? *Diabetic medicine* 1995 Sep 1; 12(9):770-6.

53. Krishnan S, Nash F, Baker N, Fowler D, Rayman G. Reduction in Diabetic Amputations Over 11 Years in a Defined UK Population Benefits of multidisciplinary team work and continuous prospective audit. *Diabetes care* 2008 Jan 1; 31(1):99-101.

54. Tseng CL, Rajan M, Miller DR, LaFrance JP, Pogach L. Trends in initial lower extremity amputation rates among Veterans Health Administration health care System users from 2000 to 2004. *Diabetes care* 2011 May 1; 34(5):1157-63.

55. van Houtum WH, Rauwerda JA, Ruwaard D, Schaper NC, Bakker K. Reduction in diabetes-related lower-extremity amputations in The Netherlands: 1991-2000. *Diabetes care* 2004 May 1; 27(5):1042-6.

56. Sloan FA, Feinglos MN, Grossman DS. Receipt of care and reduction of lower extremity amputations in a nationally representative sample of US elderly. *Health services research* 2010 Dec 1; 45(6p1):1740-62.

57. Aksoy DY, Gürlek A, Cetinkaya Y, Öznur A, Özgür F, Aydingöz Ü, Gedik O. Change in the amputation profile in diabetic foot in a tertiary reference center: efficacy of team working. *Experimental and clinical endocrinology & diabetes* 2004 Oct; 112(09):526-30.

58. Rerkasem K. Reducing lower extremity amputations due to diabetes: the application of diabetic-foot protocol in Chiang Mai University Hospital. *The international journal of lower extremity wounds* 2008 May 14.

59. Edmonds ME, Blundell MP, Morris ME, Thomas EM, Cotton LT, Watkins PJ. Improved survival of the diabetic foot: the role of a specialised foot clinic. *QJM* 1986 Aug 1; 60(2):763-71.

60. Canavan RJ, Unwin NC, Kelly WF, Connolly VM. Diabetes- and nondiabetes-related lower extremity amputation incidence before and after the introduction of better organized diabetes foot care continuous longitudinal monitoring using a standard method. *Diabetes care* 2008 Mar 1; 31(3):459-63.

61. Anichini R, Zecchini F, Cerretini I, Meucci G, Fusilli D, Alviggi L, Seghieri G, De Bellis A. Improvement of diabetic foot care after the implementation of the International Consensus on the Diabetic Foot (ICDF): results of a 5-year prospective study. *Diabetes research and clinical practice* 2007 Feb 28; 75(2):153-8.

62. Sumpio BE, Armstrong DG, Lavery LA, Andros G. The role of interdisciplinary team approach in the management of the diabetic foot: a joint statement from the Society for Vascular Surgery and the American Podiatric Medical Association. *Journal of the American Podiatric Medical Association* 2010 Jul; 100(4):309-11.

63. Huang S, Chen CS, Ingber DE. Control of cyclin D1, p27Kip1, and cell cycle progression in human capillary endothelial cells by cell shape

Living with a diabetic foot ulcer: the patient's perspective

Box 1: What is an illness narrative?

An illness narrative is derived from an individual's explanation of their struggle with a chronic or disabling illness. It is their story of living with the condition. An illness narrative or illness biography is therefore a method that enables a person to give a comprehensive account of their struggle with chronic or disabling illness. Through such narratives the complexity of the illness experience can be seen. As Hyden (1997)^[5] stated: 'One of our most powerful forms for expressing suffering and experiences related to suffering is the narrative. Patients' narratives give voice to suffering in a way that lies outside the domain of the biomedical voice.'

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Clinicians and healthcare organisations often quite rightly focus on wound healing when dealing with chronic wounds such as diabetic foot ulcers (DFUs): measuring healing rates, monitoring infection and ischaemia, and evaluating progress using an array of technologies. Managers of healthcare organisations on the other hand, look at outcomes such as amputation data and bed days as measures of success or failure.

This paper will move away from what are obviously important measures (detailed in papers 1 and 3 of this document) to focus on how having a chronic diabetic foot wound impacts patients' lives. It will look at wellbeing and quality of life, and the importance of an informed patient in the treatment pathway. It will further focus on the role of dressings and wound management, such as offloading, within the treatment pathway and how managing some of the distressing symptoms of living with a DFU, such as odour, may improve a patient's wellbeing. The paper will explore three key areas:

- Understanding the impact that having a DFU has on the person
- Reviewing the importance of consultation style and education, and how both can increase understanding and empower patients to improve wellbeing
- Identifying the required features of dressings from a clinical perspective. What are the key attributes and practical features that maximise a patient's quality of life and wellbeing?

These issues will be explored using a review of the recent literature around wellbeing. The patient stories in this paper were captured using the illness narrative technique. Informed consent was obtained from the people involved and local governance procedures for research were followed.

WELLBEING: THE PSYCHOSOCIAL IMPACT OF LIVING WITH A DFU

Wellbeing, although associated with quality of life, should be seen as a separate but linked construct. While health-related quality of life centres on the relationship between standard of living and health, wellbeing is a more subjective measure that looks at the relationship between positive emotions and contentment in the absence of 'persistent negative emotions'^[1].

A patient with a DFU is likely to experience symptoms including pain, restricted mobility, pruritus, sleep disturbance, as well as leakage and malodour from exudate at the wound site on a daily basis^[2]. For the patient the psychological impact of these symptoms span a spectrum of emotions including, embarrassment, shame, frustration and lowered self-esteem. These sometimes lead to mood disorders, such as depression and anxiety, and suicidal thoughts^[2].

While much of the work around wellbeing has focused on chronic wounds as a generic entity, some work has been conducted that focuses specifically on the impact a chronic foot ulcer has on a patient's wellbeing^[3]. Patients with a DFU experience a range of psychosocial issues that can lead to a loss of 'sense of self'^[4] and social isolation. Examples given by Kinmond et al^[4] include a grandmother who is unable to take her grandchildren to the park to feed the ducks and three men who are no longer able to play football with children/grandchildren.



Picture 1: Ruth - Day 1



Picture 2: Ruth - Visit 3

LIVING WITH DFUs: THE REAL STORY

Extracts from Ruth's story

Ruth lives in the UK and has had type 2 diabetes for 12 years. She also has moderate peripheral arterial disease and chronic venous insufficiency. She developed a moderately deep dorsal ulceration over the second and third metatarsal areas following a burn from boiling water. The wound had become chronic and had been present 8 weeks on presentation to the multidisciplinary foot team.

Clinician: Can you tell me about your foot?

Ruth: "It was a bit silly really, I dropped a cup of tea on my foot — I had no shoes on — and it burnt my foot. I didn't think anything of it and ran it under cold water and went to bed: it seemed okay. Over the next few weeks it didn't heal and it started to become more painful and smell. My leg started to swell and I got some sores on it. I stopped going out as it was painful: I tried to rest it and I used some dressings from the chemist but they kept getting wet through and the fluid was staining my footwear and making it smell. I had to throw my slippers out as they were ruined and smelled awful. My son visited me and made me go to the doctors and she gave me antibiotics and sent me here."

Clinician: What impact has the wound had on your life?

Ruth: "It has turned it upside down: the worst thing is the smell and the leaking liquid - it looks horrible and it stopped me going out. I was embarrassed. I should have gone to a friend's birthday party — she was 80 — but I couldn't go, not like that. I thought it would get better. I had lots of food in the freezer and my next-door neighbour used to bring me bread and milk. I didn't tell my family because they live a long way off: I didn't want them worrying. And like I said, I thought it would get better."

Ruth was treated with compression bandages for the leg ulceration and a charcoal dressing impregnated with silver with high absorbency (Actisorb Silver 220) for 2 weeks to address the issues she was having with fluid management, bacterial burden and odour. The dressing was switched to a foam dressing (Tielle) after 2 weeks.

Clinician: How are you feeling now?

Ruth: "Much better. When I came here I was worried what people would think, I also worried I might lose my foot — I read in the newspaper that that could happen. The podiatrist listened to my worries: I had a few! I explained I was worried about losing my foot and the awful smell; she reassured me and told me she would remove the dead tissue and give me dressings that would help with the smell and the leakage."

Extracts from Amit's story

Amit is a 52-year-old farmer from a remote village in North India. He is illiterate.

Clinician: Can you tell me about your foot?

Amit: "It's been almost a year since I was diagnosed with the disease called 'sugar' because I used to urinate a lot. I had very little knowledge about the symptoms of diabetes and how it could affect me on the whole. One cold winter night I placed my feet in front of the heater for some warmth and ended up burning the first and second toe on my right foot. I thought it was strange that I couldn't feel it. I treated it just like any other injury by applying antiseptic cream and bandages. But to my horror, after few days, the wound had a stench like a dead mouse, and it was bigger. My family and friends started to stay away from me because of the foul smell. They used to say: "This is so irritating, why can't you stay in one room?" I felt like I was carrying around a secret that I couldn't tell anyone. I decided to visit a nearby hospital, where I went 'under the knife' for debridement, but the toe could not be salvaged. The wound got bigger and was ragged."

Clinician: What impact has the wound had on your life?

Amit: "I could not go to my farms and lost the confidence that I would ever be able

Box 2: Definition of patient wellbeing

An international consensus document identified that having a chronic wound, such as a DFU impacts on a patient's 'wellbeing'. This same consensus defined 'wellbeing' as a 'dynamic matrix of factors including physical, social, psychological and spiritual'^[6]. While describing this concept of wellbeing the authors identified that people living with a wound may have different priorities when compared to those of the clinician, such as reducing the pain or odour, covering up unsightly strike-through or concerns about wearing bulky dressings that prevent them from wearing shoes, or performing daily activities^[6].

Box 3: The history of consultation

The consultation process has been researched since the 1950s. In 1957 Balint^[11] described listening as a skill and held the belief that ‘asking questions only gets you answers’. Almost 20 years later, Byrne and Long^[12] described two polar consultation styles: ‘patient-centred’ and ‘doctor-centred’. They found that 75% of doctors adopted the practice style characterised as being at the end of ‘doctor-centered’ spectrum. Subsequently, many models, including Helman^[13], Kurtz and Silvermann^[14], Pendleton et al^[15] and Neighbour^[16], have developed advocating a more patient-focused approach to consultation. In the UK, diabetes consultations has been linked to Graffey et al’s^[7] Care Planning approach. In combination, the Neighbour^[16] and Calgary Cambridge^[8] approach focuses on goal setting — a joint and negotiated approach by patient and clinician. The Calgary Cambridge model^[8] places the Disease—Illness model at the centre of information gathering, which focuses on the patient.

to work again. I asked God: ‘why me?’ It was awful: people don’t realise what it feels like when you lose your freedom; when you can’t do what you want to do. My ordeal continued as the wound never healed even after repeated visits. I felt I was living with a taboo and that there was no remedy for it, until one of my neighbours advised me to visit a diabetic foot clinic 120 miles away from my home. From the moment that I consulted a doctor who had expertise in this field, things changed for the better.”

Amit’s wound was debrided and tissue was sent to the lab for cultures. Negative pressure wound therapy (NPWT) was used to help it heal. Following this he was given antibiotics and a daily, moist wound dressing was applied for 2 weeks. Some 3 months after the onset of treatment at the specialist diabetic foot clinic, Amit was on his feet again with the help of the treatment and some special shoes.

Clinician: How are you feeling now?

Amit: “I knew when the VAC was removed to reveal a clean wound that was red like a strawberry with no foul smell whatsoever, that things would get better. It was financially draining for me, but I continued as I could see the wound was improving. The specialist not only provided treatment and shoes that got me back on my feet but also was the first person to actually take the time to counsel me on various aspects of diabetes and foot care. I realised that such a simple injury can turn into something devastating very quickly.”

DISCUSSION

Ruth and Amit’s stories show that irrespective of culture or geography the impact of diabetes and subsequent foot ulceration has a devastating affect on a patient’s wellbeing. Ruth and Amit described perfectly the social isolation, financial difficulties and the impact on lifestyle resulting from their wound — and the stigma associated with it. More importantly, they also describe the improvement in wellbeing that results from managing wounds effectively. In Ruth’s case addressing the signs and symptoms of living with the wound, which were causing her to withdraw from her social interactions. In Amit’s case via radical debridement and the use of NPWT that saw him get back on his feet and back to his farm.

THE IMPORTANCE OF THE CONSULTATION

The consultation is a pivotal moment in a patient’s health journey and it is vital that clinicians use an approach that achieves the aim of gaining all the necessary information to aid diagnosis but also takes into account the patient’s wishes and beliefs. Ruth touched on this in her narrative describing how the podiatrist had listened to and reassured her regarding her beliefs and Amit pointedly said: “He [the specialist] was the first person to take the time to counsel me on various aspects of diabetes and foot care.”

Patient-focused, personalised care planning is key to identifying and establishing issues that significantly impact the patient, addressing their fears and concerns^[7]. At the patient-focused end of the spectrum the Calgary Cambridge model^[8] helps clinicians to explore and understand the health beliefs and priorities of the patient in a time efficient way. It is a direct approach that allows for the expression of individual concerns. For example, with Ruth her concerns focused on odour and discharge along with the belief that foot ulceration leads to amputation. Failure to focus on the patient’s agenda and concentrating only on practitioner’s concerns can result in conflict, particularly around issues such as footwear and offloading.

DISCREDITED VERSIONS OF SELF

Social isolation is a common problem related to chronic conditions, such as DFUs^[4]. People with a chronic condition need to make a continuous effort to maintain a positive sense of self^[9,10]. Patients who suffer with a chronic condition, such as a chronic wound, often become highly aware of things they have lost, in particular aspects of self that were previously taken for granted. As we have seen from Ruth and Amit’s accounts, daily

activities, whether work or socialising, that they both once took for granted became difficult, if not impossible, due to the physical and psychosocial impact of their wounds. They both became embarrassed, withdrawing from daily life and subsequently lost confidence in their ability to interact with others and complete daily tasks.

Loss of self and the resulting feeling of loss of self worth are a powerful form of suffering experienced by people with a chronic condition^[9]. Chronic conditions also have an impact on patients' ability to work, financial security and social networks. All this leads to discredited definitions of 'self', loss of self worth and, ultimately, the feeling and fear of becoming a burden. As Ruth describes in her story, she didn't tell her family because she didn't want to worry them. She is not alone.

IMPLICATIONS FOR PRACTICE

The impact on a patient's wellbeing and quality of life when he/she suffer with a DFU should be explored through the consultation process. Kinmond et al^[4] describe how clinicians should focus on the individual's total experience rather than just his/her physical care. Education is vital and clinicians need to understand the 'whole' patient experience to inform education strategies, without this the patient runs the risk of being labelled as non-compliant or non-concordant.

THE ROLE OF DRESSINGS IN IMPROVING PATIENT WELLBEING

Dressing choice is as key to improving patient wellbeing as it is to managing the wound and optimising healing. Given the factors that cause patients most concern and impact wellbeing, clinicians should choose dressings that progress the wound to healing and minimise issues that the patient finds most distressing, including leakage, malodour and pain.

The key is combining the elements that clinicians believe constitute the ideal dressing with those that address patient need.

For clinicians, an ideal dressing is one that ensures optimal healing and addresses the following^[17]:

- Maintains high humidity
- Removes excess wound exudates
- Permits thermal insulation
- Impermeable
- Gaseous exchange
- Non-fibre shedding/nontoxic
- Non-adherent, comfortable and conforming.

Key performance issues of dressing from a patient perspective are related to the ability to manage effectively the wound symptoms and signs. These include^[17]:

- Remain in place
- Prevent leakage (e.g. retain fluid)
- Reduce odour
- Reduce pain.

SUMMARY

The impact on quality of life and wellbeing and the management of these distressing symptoms cannot be underestimated and should form an integral part of any wound management approach.

From a physical care perspective, steps should be taken to minimise the impact by the use of appropriate management strategies including dressing choice and appropriate methods of offloading.

REFERENCES

1. Upton D, Upton P and Alexander R. Wellbeing in wounds inventory (WOWI): development of a valid and reliable measure of well being in patients with wounds. *Journal of Wound Care* 2016; 25(3)114-119.
2. Upton D, Upton P and Alexander R. What about wellbeing? *Journal of Wound Care* 2014; 23 (1)14-17.
3. Vileikyte L. The psycho-social impact of diabetes foot damage. *Diabetes Voice* 2005; Nov 50:11.
http://www.idf.org/sites/default/files/attachments/articles_370_en.pdf
4. Kinmond K, Mc Gee P, Gough S, Ashford R. *Loss of Self: a psychosocial study of the quality of life of adults with diabetic ulceration* 2003; <http://www.worldwidewounds.com/2003/Kinmond/Loss-Of-self.html>
5. Hyden L. Illness and narrative. *Sociology of Health and Illness* 1997; 19(1): 48-69.
6. *International consensus: Optimising wellbeing in people living with a wound* 2012; <http://www.woundsinternational.com/consensus-documents/view/international-consensus-optimising-wellbeing-in-people-living-with-a-wound>
7. Gaffry JP, Eaton S, Sturt J, Chadwick PJ. Personalised care planning for diabetes: policy lessons from systematic reviews of consultation and self-management interventions. *Primary Health Care Research & Development* 2009; 10(03): 210-222.
8. Kurtz S, Silverman J, Benson J, Draper J. Marrying content and process in clinical method teaching: enhancing the Calgary-Cambridge guide. *Academic Medicine* 2003; 78(8): 802-809.
9. Charmaz, K. Struggling for a self. Identity levels of the chronically ill. In Roth JA and Conrad P (eds.). *Research in the Sociology of Health Care: The Experience and Management of Chronic Illness* 1987; 6: 283-321 Greenwich: JA1 Press.
10. Charmaz K. *Good Days, Bad Days: The Self in Chronic Illness and Time* (1991). New Jersey: Rutgers.
11. Balint M. *The Doctor, the Patient and the Illness* (1957). Edinburgh: Churchill Livingstone.
12. Byrne PS and Long BEL. *Doctors talking to Patients* (1976). London: HMSO.
13. Helman CG. Disease versus illness in General Practice. *Journal of the College of General Practice* 1981; 31: 548-62.
14. Kurtz S and Silverman J. The Calgary-Cambridge observation guides: an aid to defining the curriculum and organising the teaching in communication training programmes. *Medical Education* 1996; 30:83-9.
15. Pendleton D. *The consultation: an approach to learning and teaching*. Oxford University Press; 1984.
16. Neighbour R. *The Inner Consultation* (1987). Lancaster. MTO Press.
17. Chadwick P, Edmonds M, McCardle J, Armstrong D. *Best practice guidelines: Wound management in diabetic foot ulcers*. Wounds International 2013. Available at: www.woundsinternational.com
5. Hyden L. Illness and narrative. *Sociology of Health and Illness* 1997; 19(1): 48-69.

Managing and treating DFUs

D FUs are a manifestation of complex, chronic systemic disease and require multifaceted, multidisciplinary management to optimise outcomes. This article is based on discussions at a meeting of experts held in May 2016. It provides guidance on the local management of DFUs pre- and post-debridement. However, it does not discuss the management of surgical foot wounds in diabetic patients in which tissue loss or modification of tissue position or structure has occurred.

ASSESSMENT OF DFUs

Early referral to and assessment by an expert multidisciplinary team is key to improving outcomes, as discussed by Armstrong and Hatch (pages 4-9). Thorough assessment underpins the management of a patient with a DFU. Initial assessment should include evaluation of:

- Diabetes management and blood glucose control
- Previous history of foot ulceration and surgery
- Smoking status
- Symptoms and signs of peripheral artery or venous disease
- Symptoms and signs of peripheral neuropathy
- Musculoskeletal evaluation, e.g. for overall flexibility, range of movement in the ankle, foot shape
- Systemic signs of infection
- Pain, e.g. neuropathic pain, wound-related pain
- Socioeconomic circumstances, dexterity, visual acuity and insight^[1,2].

WOUND ASSESSMENT

The purposes of local DFU assessment (Box 1, page 18) include providing a baseline from which to measure healing progress and to identify signs that indicate an appropriate management approach, including referral needs (e.g. for vascular assessment, review of diabetes management), dressing type and, very importantly, whether treatment for infection is required.

One classification system that was discussed during the meeting was the WIfI (Wound Ischaemia, foot, Infection) classification system for the 'threatened lower limb' as a means of assessing the wound as discussed by Armstrong and Hatch (pages 4-9).

WOUND SIZE

Wound size is frequently used to monitor healing progress. A lack of change in size may indicate that healing has stalled or that infection is imminent. A sudden increase in size may indicate that the DFU has become infected.

Wound measurement should take place after debridement. Measurement of wound length and width using a ruler is a common approach to determining wound size. Multiplication of the measurements is often used to calculate wound area. However, this approach is likely to overestimate wound area by as much as 40% in comparison with more accurate methods such as planimetry based on wound photographs or tracings^[4].

Several studies have used planimetry to confirm that early reductions in the area of DFUs predict full epithelialisation later on (Table 1, page 19). A percentage wound area reduction of 10%-15% per week or $\geq 50\%$ after 4 weeks of treatment predicts healing^[5]. For practical purposes, 4 weeks is often the time interval at which changes in wound area are evaluated (Figure 1, page 20).

Box 1: Initial local assessment of DFU

A physical examination should determine:

- If the foot is predominantly neuropathic, ischaemic or neuroischaemic?
- If it is ischaemic, is there critical limb ischaemia?
- If there are any musculoskeletal deformities?

In addition, the following should be observed and recorded:

- Wound location* — e.g. medial/lateral, plantar/dorsal, toe, interdigital
- Wound size
 - Length and width
 - Area**
 - Depth
 - Volume**
- Tissue types present
 - Eschar, slough, granulation tissue, epithelialisation, necrotic tissue, underlying structures (e.g. tendons, joint capsule, bone, orthopaedic implants)
 - Include descriptors such as colour and friability
 - Percentage of wound area covered by each tissue type/colour
- Exudate level
 - Amount of exudate***
 - Colour
 - Viscosity
 - Purulent
 - Current dressing, e.g. for sticking, leakage or strike-through
- Wound edge
 - Raised edge
 - Callus
 - Undermining/tracks/sinuses — record location‡ and length
- Surrounding skin
 - Maceration/excoriation — record location‡ and extent from wound edge
 - Erythema — record location‡ and extent from wound edge
 - Oedema
- Odour
 - Presence and nature
- Pain
 - Local pain
 - Level of pain
- Signs of infection (see text)

*If more than one wound is present, assess individually and check whether they are physically linked by a track or sinus.

**Automated devices for measuring wound area and volume are available. They are widely used by the clinicians in the expert panel.

***Assessment of levels of exudate production is difficult and highly subjective. Levels are often characterised as low/moderate/high or +, ++, +++. Assessment of the appearance of the wound bed (dry/moist/wet) and the dressing:exudate interaction may assist^[3].

‡'Clock face' diagrams may aid recording.

Repeated measurement of wound depth, degree of undermining and length of tunnelling also provides useful information for monitoring. As a wound heals, wound depth and volume will decrease due to granulation tissue ingrowth, and area will decrease as new epithelium forms^[10].

SIGNS OF INFECTION

Infection is a major threat in DFUs, more so than in wounds of other aetiologies not subject to diabetic changes. It has potentially serious implications because of its ability to destroy tissue, and its association with amputation. About half of all DFUs are clinically infected at the time of presentation^[11,12,13], and infection precedes about 60% of amputations^[14].

Guidelines recommend that infection in DFUs is diagnosed on the basis of the presence of two or more of the following:

- Local swelling or induration
- Erythema
- Local tenderness or pain
- Local warmth
- Purulent discharge^[15,16].

Neuropathy and peripheral vascular disease may blunt or mask signs and symptoms of infection in DFUs^[17]. Up to 50% of patients do not present with classic signs of infection, such as redness, heat and swelling^[18]. In such cases, diagnosis of infection may rely on recognition of more subtle local signs of infection, which may include:

- Increased exudate
- Friable or discoloured granulation tissue
- Undermining of wound edges
- Foul odour^[15].

It is important to recognise the subtle signs of infection which may include just one of the signs in list one, combined with two local signs of infection (list two). Key to identifying these subtle changes is continuity of care across the multidisciplinary team (MDT) and specialist care to understand the underlying disease pathologies. In severe infection, systemic signs such as fever or hypothermia, increased heart and respiratory rates, and high or low white cell counts may also occur^[15].

DFU infection is classified as mild, moderate or severe according to the extent and severity of the clinical signs, and whether systemic symptoms are present^[17]. Osteomyelitis may occur in any of these categories^[19]. The diagnosis of infection in a DFU is made largely on a clinical basis. However, if infection is suspected, the DFU should be sampled after debridement for microbiological analysis^[18,20]. The results should be used to guide antibiotic selection^[21].

There is much interest in a possible role of biofilms in wound infection. Although it is not possible to identify biofilm using the naked eye or routine culture techniques, a study using electron microscopy found biofilms in a high proportion of DFUs^[22,23]. Even so, it is not yet clear if the presence of biofilms in a wound is always harmful, and it has been suggested that it may even protect against infection^[23].

MONITORING/REASSESSMENT

As some aspects of DFU assessment, e.g. description of colour, are subjective, and DFUs may exhibit subtle signs of deterioration, regular reassessment by the same person will help to detect problems early and provide consistency.

After the initial assessment, reassessment should focus on changes in wound size, wound bed and exudate level and, importantly, detection of signs of

Table 1: Percentage area reduction as a predictor of healing in DFUs ^[6-9]	
Study	Outcome(s)
Sheehan et al, 2003 ^[6]	■ 53% area reduction at 4 weeks was associated with a significantly higher probability of healing at 12 weeks (p<0.01)
Lavery et al, 2008 ^[7]	■ ≥15% area reduction at one week or ≥60% at 4 weeks was associated with a higher probability of healing at 16 weeks
Coerper et al, 2009 ^[8]	■ ≥50% area reduction at 4 weeks was associated with a significantly higher probability of healing at 12 weeks, 16 weeks and 1 year (all p<0.01)
Snyder et al, 2010 ^[9]	■ ≥50% area reduction at 4 weeks was associated with a significantly higher probability of healing by 12 weeks (p<0.01) ■ DFUs that healed by week 12 had significantly greater % area reduction at weeks 1, 2 and 3 than DFUs that did not heal (p<0.01)

infection. Signs of deterioration should be investigated to determine cause, e.g. developing infection, poor glycaemic control or suboptimal pressure redistribution, and to indicate referral or further treatment as appropriate.

A critical interval is 4 weeks after the start of treatment when a wound area reduction of <50% indicates that the DFU is unlikely to heal and that the patient and the wound should be reassessed fully with changes made to management as appropriate (Figure 1)^[24].

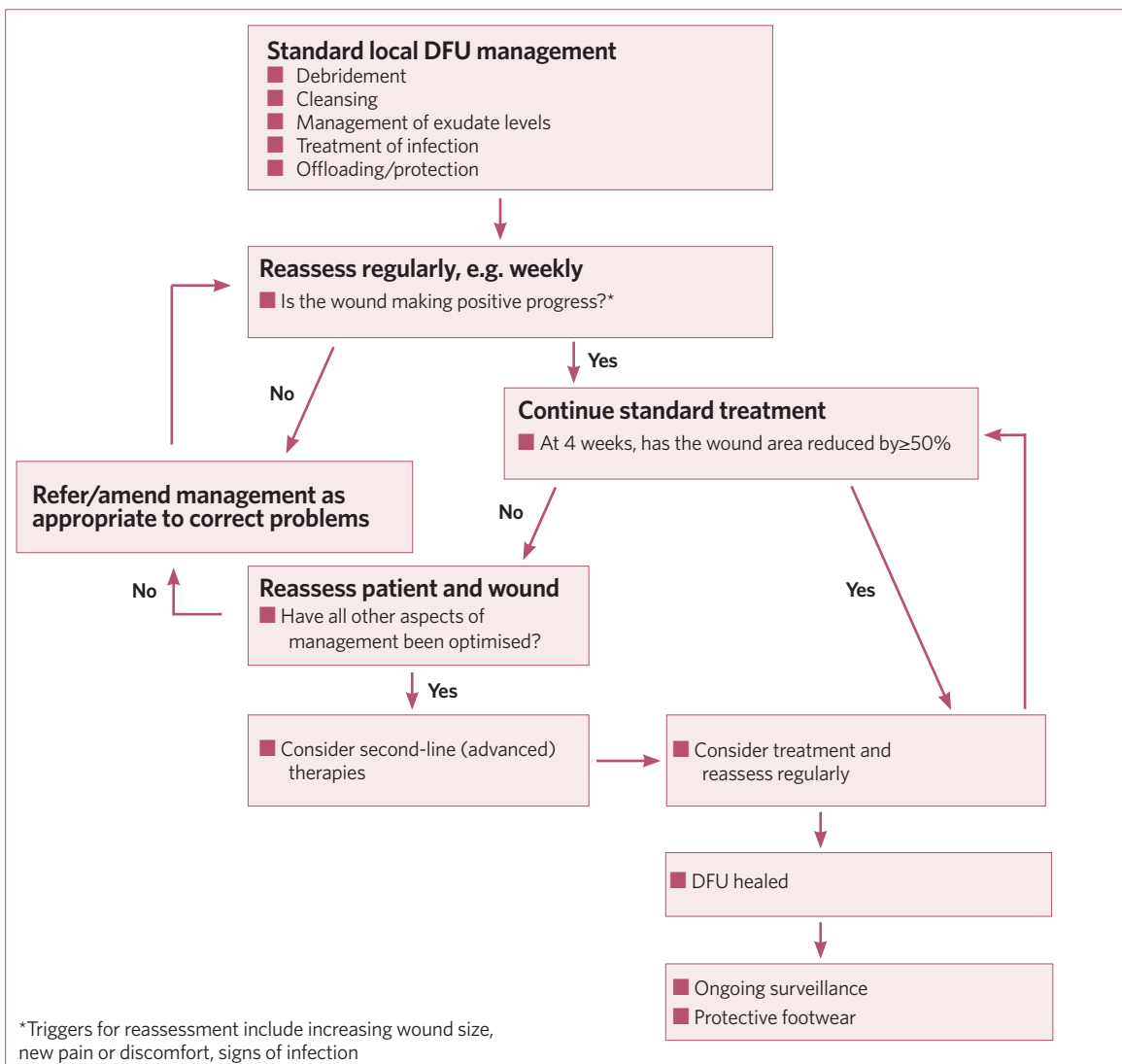
PRINCIPLES OF LOCAL MANAGEMENT

Local management of DFUs should take place in the context of optimisation of blood glucose control, treatment of vascular insufficiency and other comorbidities, offloading/ protection (removal of pressure), and patient/carer education (Figure 1)^[24].

Debridement

Regular debridement is an important aspect of DFU management and aims to remove slough, non-viable tissue and hyperkeratotic wound margins (callus). Sharp debridement carried out by experienced clinicians with specialist training is widely used in treatment of DFUs, but should be used with caution in a patient with an ischaemic foot^[25,26]. Autolytic debridement facilitated by dressings may have a role.

Figure 1 | Principles of local management of DFUs
(adapted from Frykberg & Banks, 2016)^[24]



Box 2: Antiseptic solutions containing sodium hypochlorite

Antiseptic solutions containing sodium hypochlorite, e.g. Dakin's, have been used since the early 20th century to cleanse wounds because of their broad bactericidal effect. However, hypochlorite fell out of favour because of concerns that it is cytotoxic to human cells and may therefore damage wound tissues^[28]. Similar concerns have been expressed about hydrogen peroxide^[29]. Despite this, short-term use of hypochlorite or hydrogen peroxide is advocated by some clinicians to reduce bacterial burden in DFUs on the basis that the potential benefits of reducing bacterial load in the wound, and hopefully avoiding infection, greatly outweigh possible detrimental effects on wound tissues.

Cleansing

DFUs are generally cleansed with water or saline^[27]. If slough is present, a gentle rubbing action during cleansing may aid detachment. In wounds that are infected some clinicians choose to use antiseptic solutions, e.g. hypochlorite or hydrogen peroxide^[28,29], for cleansing. Two members of the expert panel use hypochlorite to cleanse infected wounds, when appropriate. (Hypochlorite must be used only by experienced clinicians and close monitoring is required.)

Managing exudate levels

Management of exudate levels is a major factor in selecting topical treatment for DFUs. Management objectives are often to maintain a moist wound bed to aid cell migration and facilitate autolysis of slough, while preventing periwound maceration.

For dry necrotic areas, the aim is often to keep the necrotic tissue dry to prevent infection and to allow for autodebridement. Dressings must be able to cope with the amount of exudate and be able to withstand the weight-bearing forces of the foot during gait.

Protection/offloading

Pressure generated during walking is an important contributor to the development of DFUs^[30]. As a result, a fundamental principle of the management of DFUs is to shield the foot from these forces through the use of devices that redistribute pressure (offload) and provide protection. Effective offloading of the diabetic foot is essential.

There are a number of offloading modalities available for the management of DFUs, ranging from irremovable and removable devices through to insoles and orthoses. Choice of modality will be dependent on a range of patient-related factors, for example, concordance with the device, the patient's mobility and his/her daily, regular activities.

Devices include:

- Total contact casts (TCC) — the 'gold standard' method of offloading for plantar DFUs
- Removable lower limb casts or boots
- Scotchcast boots
- Healing sandals
- Half shoes
- Felted shoe inserts/dressings^[31,32].

Although non-removable devices produce higher healing rates than removable devices, in general, any form of offloading is better than none^[5,33].

PRINCIPLES OF DRESSING USE

The selection of dressings in DFUs is dependent on the aims of use (Figure 2, page 23).

Management of high exudate

In DFUs containing slough and producing high levels of exudate, the aims of dressing include managing exudate and achieving moisture balance and prevent periwound maceration/excoriation.

Consequently, an absorbent dressing should be selected as appropriate to the exudate levels, e.g. a low adherent viscose or silicone dressing, foam, alginate or carboxymethylcellulose dressing.

Management of low exudate

In a wound with low exudate levels that contains slough, the aim is to increase wound moisture to aid autolysis. This can be achieved through retention of any moisture in the wound, e.g. by a foam dressing, or by use of a high water content dressing such as a hydrogel.

Management of dry, necrotic, black tissue

In contrast, for black, dry necrotic toes due to ischaemia, the aim of dressing use is to keep the toe dry to prevent infection developing and to protect adjoining or adjacent tissues. Placing a low adherent dressing between the toes or the use of tubular gauze sleeves may assist with these aims.

General comment

Common to all wound types is the aim of reducing the risk of infection by preventing external contamination, and to reassure and comfort the patient. In DFUs, dressing choice is complicated by the use of protective/offloading devices. It is very important that any dressing selected is thin and conformable, does not cause additional pressure on foot tissues, and is able to remain in place without wrinkling or creasing^[34].

Oedema

Oedema, if present, may increase the risk of skin damage from dressing adhesives or fixatives. Oedema in the foot and lower leg must be evaluated (e.g. venous insufficiency, cardiac or pulmonary disease, kidney-related conditions) and treated. Oedema reduction can be achieved by compression therapy if there is no arterial insufficiency. When reduction is achieved a compression stocking can be worn dependent on the cause of the oedema. This will reduce the risk of pressure on the leg/foot when wearing offloading devices.

Deep wounds

Deep wounds should be packed with a dressing material appropriate for exudate level (in rope, ribbon or strip form) to ensure that the dressing material eliminates dead space and is in contact with the wound bed. However, it is important to ensure that the wound is not over-packed and that plugging of the wound (where the dressing forms a hard plug at the surface of the wound, but exudate pools behind it and is not absorbed) is avoided.

Tunnels should be packed initially to prevent collapse, but once healing is established and the walls become self-supporting, packing may be unhelpful.

In deep DFUs, particularly if exudate levels are high, NPWT may be useful in aiding healing by removing exudate, reducing oedema, encouraging granulation tissue formation and wound contraction^[16,35,36,37,38]. Once the wound base has filled in, management can be changed to a wound dressing to encourage epithelialisation.

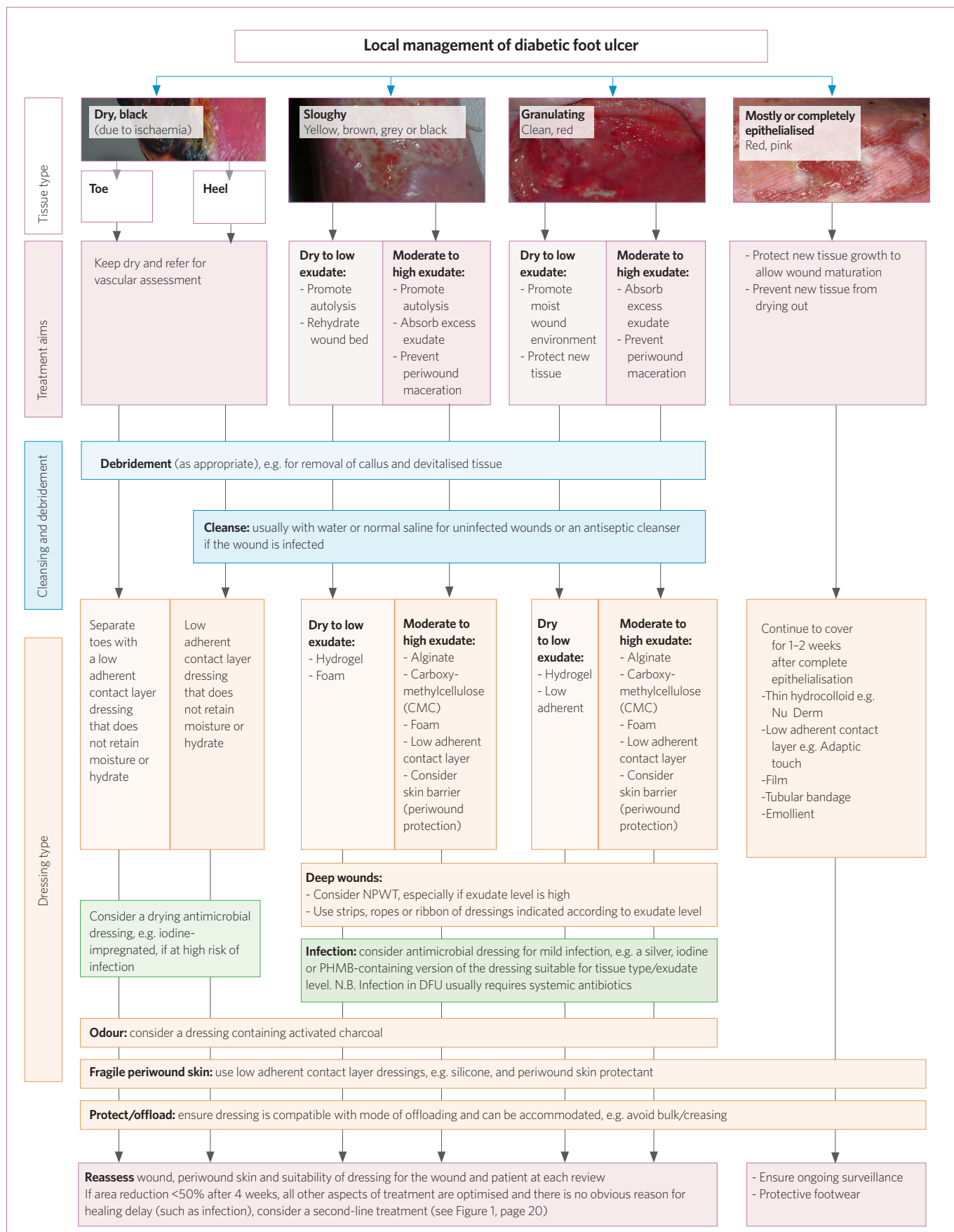
Infected wounds

The mainstay of the management of infected DFUs is systemic antibiotics given orally or parenterally depending on the severity of the infection^[39,40]. Infected DFUs require close monitoring and frequent dressing changes so that additional interventions can be implemented if there is deterioration.

Topical antimicrobial agents, e.g. in cleansers or in dressings, are used sometimes in mild infections or to prevent infection in DFUs strongly suspected of being about to develop infection^[15,40]. The use of topical antimicrobials on uninfected DFUs continues to be debated. However, because of the seriousness of infection in these ulcers, clinicians often have a lower threshold for treating high bioburden here than in other wound types.

Determining when a DFU is about to 'tip' into infection is heavily reliant on clinical experience, a high index of suspicion and detection of changes in the wound and/or patient that may be very subtle. Continuity of care is important: clinicians develop a relationship with both the patient and the wound, as such they can usually spot changes in the wound even before frank signs of infection develop. These subtle signs are often difficult to describe and are usually poorly documented. This is when many clinicians may reach for topical antimicrobial agents to prevent the progression of the infection and the need for systemic antibiotics.

Figure 2 | Local management of DFUs



Frequently used topical antimicrobial agents include iodine- or silver-impregnated dressings and antiseptic cleansing agents^[41]. The majority of clinicians on the expert panel said they would use iodine where there is a high level of suspicion of infection. The principle of the two-week challenge is recommended, i.e. if after 2 weeks no improvement is seen, the antimicrobial agent in use should be discontinued and an alternative considered^[42].

Periwound skin

Prevention of periwound maceration and excoriation is important as they may precede wound expansion or disrupt treatment. This involves avoidance of skin contact with exudate, e.g. through the use of appropriate absorbent dressings or NPWT. Where dressings are used, low adherent or silicone dressings, avoidance of tape fixatives and periwound skin protectant creams or barrier films may reduce the risk of skin damage^[43]. Tubular gauze may be useful for keeping dressings in place.

Odour

Unpleasant odour arising from a wound is usually due to putrefaction of necrotic tissue or infection. If odour occurs, debridement will aid removal of necrotic tissue. The wound should be assessed and treated as appropriate for infection. Charcoal dressings can be used to absorb odour^[16].

Dressing fixation and change frequency

Dressings and fixatives used on toes should not encircle the digit because of the risk of constriction which can trigger ischaemia.

Although, ideally, dressing change frequency should be minimised to reduce the potential for external contamination, clinicians need to be aware that DFUs can deteriorate very quickly. A DFU that is of concern should be monitored frequently, as often as every 1–2 days where infection is present and antibiotic therapy has not yet started, has only just commenced or where wound culture sensitivities are awaited. This is particularly important if there are systemic signs of infection.

Pain

Despite the frequency of sensory neuropathy in patients with DFUs, about 50% of patients experience wound-related pain^[44]. Newly occurring pain may be related to the development of infection. Dressing change-related pain can be minimised by paying careful attention to dressing change technique and using dressings that do not adhere and are easy to remove^[45,46].

Consequently, dressing choice for a DFU should be based on thorough assessment and consideration of overall treatment aims and exudate level. Other factors that may affect dressing choice are depth of the wound, use of offloading/protective devices (i.e. the dressing needs to be thin to avoid adding pressure), allergies/sensitivities, availability and budgetary considerations.

SECOND-LINE (ADVANCED) TOPICAL TREATMENTS

If a DFU has not reduced in size by 50% over 4 weeks despite optimised management of blood glucose and ischaemia, concordance with offloading/protection and exclusion of infection, second-line (advanced) treatments may be indicated. In the main, the Expert Group uses collagen dressings or NPWT as second-line/advanced treatments.

Collagen dressings are designed to reduce the elevated protease and inflammatory cytokine activity that may characterise stalled, chronic wounds^[47]. Some formulations of collagen dressings also contain silver, so have additional antimicrobial properties.

NPWT induces angiogenesis, granulation tissue formation and wound contraction, and reduces oedema^[37]. As discussed previously, NPWT is especially useful for highly

Box 3: Advanced treatments

In the context of topical wound management, the terms 'advanced treatments' or 'advanced therapies' are sometimes used in the literature to refer to all topical treatments other than very simple dressings such as gauze. Alternatively, they may refer to treatments such as topical growth factors or devices such as NPWT. In this paper, the term is used to indicate topical treatments that are used second-line, i.e. after an initial treatment selected according to the needs of the wound and the patient, has not been effective.

exuding, deep DFUs. It is also used to aid healing following diabetic foot surgery, but should be avoided in ischaemic or infected wounds^[38]. The use of NPWT with cyclical instillation of topical solutions, such as antimicrobial agents, into the wound bed is under investigation^[48].

Other second-line treatments include skin grafts, topical growth factors, bioengineered skin equivalents, acellular matrices and stem cell therapy^[5,49,50].

SELF-CARE

Many patients with DFUs, particularly the younger patients, manage their own wound care and dressing changes to some extent. Self-care will become increasingly important as diabetes, and so DFUs, becomes more prevalent, but healthcare resources remain constrained. Patients' and carers' suitability for home care needs to be assessed carefully. The patient or carer needs to have sufficient visual acuity, physical flexibility and dexterity to change dressings and check the wound, and to have sufficient insight into the disease to be able to request help if the wound deteriorates. The use of a patient diary may help to track treatment and monitor the wound to detect changes.

PALLIATIVE MANAGEMENT

Generally, the goal of treatment of a DFU is to achieve total healing. However, in some patients this may not be appropriate or realistic, e.g. because the patient is very frail, has inoperable peripheral vascular disease or is terminally ill. It is important that treatment aims are discussed with the patient and carers, and a suitable management plan is formulated. The aims of the plan may include prevention of infection or deterioration, management of exudate, odour and pain, maximising function and minimising impact on quality of life, and simplifying wound care^[51].

MANAGEMENT OF HEALED WOUNDS

The annual risk of a diabetic patient developing a DFU is around 2%. However, in patients who have already had a DFU the risk of another appearing in the next three years is 17%–60%^[52]. A patient with a healed DFU should therefore be considered in remission rather than cured.

When a DFU is approaching complete epithelialisation, protective footwear should be ordered or availability ensured. The patient should be referred to a foot surveillance service if available and encouraged to perform regular foot examinations^[53].

It is common practice for a dressing (e.g. foam, hydrocolloid, low adherent or film) or tubular bandage and offloading/protection to be continued for 1–2 weeks after a DFU has healed, sometimes at the request of the patient (Figure 2, page 23). If the patient chooses to continue placing a dressing on the healed wound after that time, it is important that he/she understands the need for a thin and conformable dressing and to avoid wrinkling or creasing. Patients should be reminded about whom to contact if they develop any problems. They should also be made aware that recurrence is common and educated to understand that they are entering remission not cure.

CONCLUSION

Local management of DFUs is affected by a wide range of factors, including exudate level, aims of treatment and the use of offloading/protection devices. In general, first-line dressings need to be thin and conformable to avoid causing additional pressure and to have appropriate absorptive capacity to prevent periwound skin damage. Although not always available, NPWT has an important role to play in the management of deep, highly exuding DFUs. DFUs are at high risk of infection and need to be monitored carefully. Second-line (advanced) treatments may be indicated if, after 4 weeks of optimised management and exclusion of infection, the wound area has not reduced by 50%.

REFERENCES

1. Woo KY, Botros M, Kuhnke J, et al. Best practices for the management of foot ulcers in people with diabetes. *Adv Skin Wound Care* 2013; 26(11):512-24.
2. Miller JD, Carter E, Shih J, et al. The 3-minute diabetic foot exam. *J Family Practice* 2014; 63(11):646-56.
3. World Union of Wound Healing Societies (WUWHS). *Principles of best practice: wound exudate and the role of dressings. A consensus document*. London: MEP Ltd, 2007. Available at: www.woundsinternational.com
4. Rogers LC, Bevilacqua NJ, Armstrong DG, Andros G. Digital planimetry results in more accurate wound measurements: a comparison to standard ruler measurements. *J Diabetes Sci Technol* 2010; 4(4):799-802.
5. Hingorani A, LaMuraglia GM, Henke P, et al. The management of diabetic foot: a clinical practice guideline by the Society for Vascular Surgery in collaboration with the American Podiatric Medical Association and the Society for Vascular Medicine. *J Vasc Surg* 2016; 63:35-215.
6. Sheehan P, Jones P, Caselli A, et al. Percent change in wound area of diabetic foot ulcers over a 4-week period is a robust predictor of complete healing in a 12-week prospective trial. *Diabetes care* 2003; 26(6):1879-82.
7. Lavery LA, Barnes SA, Keith MS, et al. Prediction of healing for postoperative diabetic foot wounds based on early wound area progression. *Diabetes care* 2008; 31(1):26-29.
8. Coerper S, Beckert S, Küper MA, et al. Fifty percent area reduction after 4 weeks of treatment is a reliable indicator for healing – analysis of a single-center cohort of 704 diabetic patients. *J Diabetes Complications* 2009; 23(1):49-53.
9. Snyder RJ, Cardinal M, Dauphinée DM, Stavosky J. A post-hoc analysis of reduction in diabetic foot ulcer size at 4 weeks as a predictor of healing by 12 weeks. *Ostomy Wound Manage* 2010; 56(3):44-50.
10. Gethin G. The importance of continuous wound measuring. *Wounds UK* 2006; 2(2):60-68.
11. Armstrong DG, Lipsky BA. Diabetic foot infections: stepwise medical and surgical management. *Int Wound J* 2004; 1(2):123-32.
12. Prompers L, Huijberts M, Apelqvist J, et al. High prevalence of ischaemia, infection and serious comorbidity in patients with diabetic foot disease in Europe. Baseline results from the Eurodiale study. *Diabetologica* 2007; 50(1):18-25.
13. Lavery LA, Armstrong DG, Peters E, Lipsky BA. Probe-to-bone test for diagnosing diabetic foot osteomyelitis. *Diabetes care* 2007; 30:270-74.
14. Lipsky BA. Medical treatment of diabetic foot infections. *Clin Infect Dis* 2004; 39(suppl 2):S104-14.
15. Lipsky B, Berendt A, Cornia PB. 2012 Infectious Diseases Society of America clinical practice guideline for the diagnosis and treatment of diabetic foot infections. IDSA guidelines. *Clin Infect Dis* 2012; 54(12):132-73.
16. Registered Nurses' Association of Ontario. *Assessment and management of foot ulcers for people with diabetes* (2nd edition). Toronto: Registered Nurses' Association of Ontario, 2013.
17. Bakker K, Apelqvist J, Schaper NC, on behalf of the International Working Group on the Diabetic Foot Editorial Board. Practical guidelines on the management and prevention of the diabetic foot 2011. *Diabetes/Metabolism Res Rev* 2012; 28(suppl 1):225-31.
18. Chadwick P, McCardle J. Assessing infected ulcers: a step-by-step guide. *J Wound Care* 2015; 24(5):15-19.
19. Edmonds M. The treatment of diabetic foot infections: focus on ertapenem. *Vasc Health Risk Manage* 2009; 5:949-63.
20. *International Best Practice Guidelines. Wound management in diabetic foot ulcers*. Wounds International, 2013. Available at: www.woundsinternational.com
21. Richard J-L, Sotto A, Lavigne J-P. New insights in diabetic foot infection. *World J Diabetes* 2011; 2(2):24-32.
22. Phillips PL, Wolcott RD, Fletcher J, et al. *Biofilms Made Easy*. Wounds International 2010; 1(3). Available at: <http://www.woundsinternational.com>
23. Richard J-L, Lavigne J-P, Sotto A. Diabetes and foot infection: more than double trouble. *Diabetes Metab Res Rev* 2012; 28(suppl 1):46-53.
24. Frykberg RG, Banks J. Management of diabetic foot ulcers: a review. *Federal Practitioner* 2016; 33(02):16-23.
25. Edmonds ME, Foster AVM. Diabetic foot ulcers. *BMJ* 2006; 332(7538):407-10.
26. McIntosh C. Importance of wound debridement in management of diabetic foot ulcers. *Wounds UK* 2009; 4:122-25.
27. Wolcott RD, Fletcher J. Technology update: role of wound cleansing in the management of wounds. *Wounds UK* 2014, Jun 1;10(2).
28. Wilson JR, Mills JG, Prather ID, Dimitrijevic SD. A toxicity index of skin and wound cleansers used on invitro fibroblasts and keratinocytes. *Adv Skin Wound Care* 2005; 18(7):373-78.
29. Lineaweaver W, Howard R, Soucy D, et al. Topical antimicrobial toxicity. *Arch Surg* 1985; 120(3):267-70.
30. de Oliveira ALM, Moore Z. Treatment of the diabetic foot by offloading: a systematic review. *J Wound Care* 2015; 24(12):560-70.
31. Cavanagh PR, Bus SA. Off-loading the diabetic foot for ulcer prevention and healing. *J Vasc Surg* 2010; 52:375-435.
32. Bus SA, van Deursen RW, Armstrong DG, et al. Footwear and offloading interventions to prevent and heal foot ulcers and reduce plantar pressure in patients with diabetes: a systematic review. *Diabetes Metab Res Rev* 2016; 32(suppl 1):99-118.
33. Lewis J, Lipp A. Pressure-relieving interventions for treating diabetic foot ulcers. *Cochrane Database Syst Rev* 2013; 1:CD002302.
34. Chadwick P, Edmonds M, McCardle J, Armstrong D. *Best practice guidelines: Wound management in diabetic foot ulcers*. Wounds International. 2013.
35. Speak K. Management of highly exuding diabetic foot ulcers. *The Diabetes Foot J* 2014; 17(2):64-68,
36. Scottish Intercollegiate Guidelines Network (SIGN). *Management of diabetes*. Health Improvement Scotland, 2014. Available at: www.sign.ac.uk

37. Hasan MY, Teo R, Nather A. Negative-pressure wound therapy for management of diabetic foot wounds: a review of the mechanism of action, clinical applications and recent developments. *Diabetic Foot & Ankle* 2015; 6:27618.
38. Meloni M, Izzo V, Vainieri E, et al. Management of negative pressure wound therapy in the treatment of diabetic foot ulcers. *World J Diabetes* 2015; 6(4):387-93.
39. Bowering K, Embil JM. Foot care. *Can J Diabetes* 2013; 37:S145-49.
40. Lipsky BA, Aragon-Sanchez J, Diggle M, et al. *IWDGF Guidance on the diagnosis and management of foot infections in persons with diabetes*. International Working Group on the Diabetic Foot, 2015. Available at: http://www.iwgd.org/files/2015/website_infection.pdf
41. World Union of Wound Healing Societies (WUWHS). *Principles of best practice: wound infection in clinical practice. An international consensus*. London: MEP Ltd, 2008. Available at: www.woundsinternational.com
42. *International consensus. Appropriate use of silver dressings in wounds. An expert working group consensus*. London: Wounds International, 2012. Available at: www.woundsinternational.com
43. Bianchi J. Protecting the integrity of the periwound skin. *Wound Essentials* 2012; 1:58-64.
44. Bengtsson L, Jonsson M, Apelqvist J. Wound-related pain is underestimated in patients with diabetic foot ulcers. *J Wound Care* 2008; 17(10):433-35.
45. World Union of Wound Healing Societies (WUWHS). *Principles of best practice: minimising pain at wound dressing-related procedures. A consensus document*. London: MEP Ltd, 2004. Available at: www.woundsinternational.com
46. Baker N. Implications of dressing-related trauma and pain in patients with diabetes. *The Diabetic Foot J* 2012; 15(4 suppl):2-8.
47. Cullen B, Ivins N. *Promogran and Promogran Prisma Made Easy*. Wounds International 2010; 1(3): Available at: www.woundsinternational.com
48. Dale AP, Saeed K. Novel negative pressure wound therapy with instillation and the management of diabetic foot infections. *Curr Opin Infect Dis* 2015; 28(2):151-57.
49. Yang M, Sheng L, Zhang TR, Li Q. Stem cell therapy for lower extremity diabetic ulcers: where do we stand? *BioMed Res Int* 2013:462179
50. Yazdanpanah L, Nasiri M, Adarvishi S. Literature review on the management of diabetic foot ulcer. *World J Diabetes* 2015; 6(1):37-53.
51. Dunning T. Integrating palliative care with usual care of diabetic foot wounds. *Diabetes Metab Res Rev* 2016; 32 (suppl 1):303-10.
52. Dubsky M, Jirkovska A, Bem R, et al. Risk factors for recurrence of diabetic foot ulcers: prospective follow-up analysis in the Eurodiale subgroup. *Int Wound J* 2012; 10:555-61.
53. Mayfield JA, Reiber GE, Sanders LJ, et al. Preventive foot care in people with diabetes. *Diabetes care* 1998; 21(12):2161-77.



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