

## Meeting report: Go beyond: A multidisciplinary approach for the management of diabetic foot ulcers



**Authors**  
(clockwise from top left): Maciej Zielinski, Luca Dalla Paola and José Luis Lázaro Martínez

Diabetic foot ulcers are among one of the major global medical issues, with considerable economic and human cost. A multifaceted approach requires a continuation of care provided by the multidisciplinary team (MDT). In a symposium presented at the European Wound Management Association conference on Thursday 10 May, 2018, in Krakow, Poland, the speakers discussed the MDT approach and the increasing role of surgery in diabetic foot prevention and treatment, especially in the case of coexisting infection.

**M**aciej Zielinski kicked off the symposium describing the burden of diabetic foot ulcer (DFUs) globally. Approximately 8.8% (425 million) of the world's adult population has diabetes, and this is predicted to increase by 48% by 2045 (International Diabetes Federation [IDF], 2017). Elevated glycaemic levels are associated with macrovascular complications (coronary artery disease, peripheral arterial disease, and stroke) and microvascular complications (diabetic nephropathy, neuropathy, and retinopathy) (Fowler, 2008). There are estimated to be 5 million deaths globally from diabetes-related complications annually, which is more than HIV, TB and malaria combined (World Health Organization, 2016).

A DFU is often the first complication of diabetes and the most common reason for hospitalisation in the diabetes mellitus population. Its aetiology is related to the dynamic interplay of major morbidity factors: angiopathy, structural deformity, microtrauma, infection and neuropathy. Angiopathy leads to ischaemia, and foot deformation causes further chronic soft tissue breakdown by focal pressure point formation, and microtrauma increases the risk of infection (Hobizal and Wukich, 2012). Finally, diabetic neuropathy can lead to loss of protective sensation in the feet and, therefore, an increase in injuries that may go undetected and lead to infection and

ulceration over time (Alexiadou and Doupis, 2012). Up to 25% of the current global diabetes population will develop a DFU (Singh et al, 2005; Armstrong et al, 2017). DFUs are associated with increased morbidity and mortality; the 5-year relative mortality after a DFU is 48%, which is higher than most types of cancers (e.g. breast, lymphoma) (IDF, 2017). *Table 1* includes the intrinsic and extrinsic risk factors for DFU.

The cost of treating and managing DFUs is high; in the US and Europe, the costs associated with diabetes are increasing by approximately US\$9-13 billion and up to €10 billion per year respectively (Prompers et al, 2008; Rice et al, 2014). Therefore, prevention and prompt treatment is required to reduce the economic and human costs of DFUs.

### DFU prevention

The primary prevention of DFUs focuses on a holistic approach to the management of related comorbidities (Chadwick and Armstrong, 2017). As such, the IDF (2017) recommend that all people with diabetes should be screened, risk assessed and stratified to signal the appropriate clinical pathway. Additionally, it has been estimated that less than one third of physicians recognise the symptoms of diabetic peripheral neuropathy (even when it is symptomatic), and discuss them with their patients (IDF, 2017). Therefore, improving knowledge and understanding of the

### Speakers

**Maciej Zielinski** is Assistant Professor, Department of Vascular Surgery, Poznan University of Medical Sciences, Poland

**Luca Dalla Paola** is Full Professor, Department of Medical Sciences, Ferrara University School of Medicine, Chairman Diabetic Foot Unit, Maria Cecilia Hospital, Italy

**José Luis Lázaro Martínez** is Tenured Professor, Clinical Director, Head of Diabetic Foot Unit, Teaching Podiatric Clinic, Madrid, Spain

Table 1. Diabetic foot ulcer (DFU) risk factors.

Intrinsic	Extrinsic
Neuropathy	Microtrauma
Ischaemia	Ill-fitting footwear
Sub-optimal glucose control	Intensive walking
Hyperlipidaemia	Inappropriate personal hygiene
Insulin resistant	Thermal injury
Endothelial dysfunction	Hot water
Hypercoagulability	Freezing injury
Diabetes duration	Inappropriate cosmetic exercise
DFU history	Nail cut
HA	Corn, callus removal
Obesity	Work time injury
Immunopathy	Insufficient education/ cooperation
Structural deformity	Malnutrition
Biomechanics' dysfunction	Cigarette smoking
Joints dysfunction	Elderly
Vision dysfunction	Low health service availability
Chronic renal insufficiency	Low healthcare quality
Hyperkeratosis	

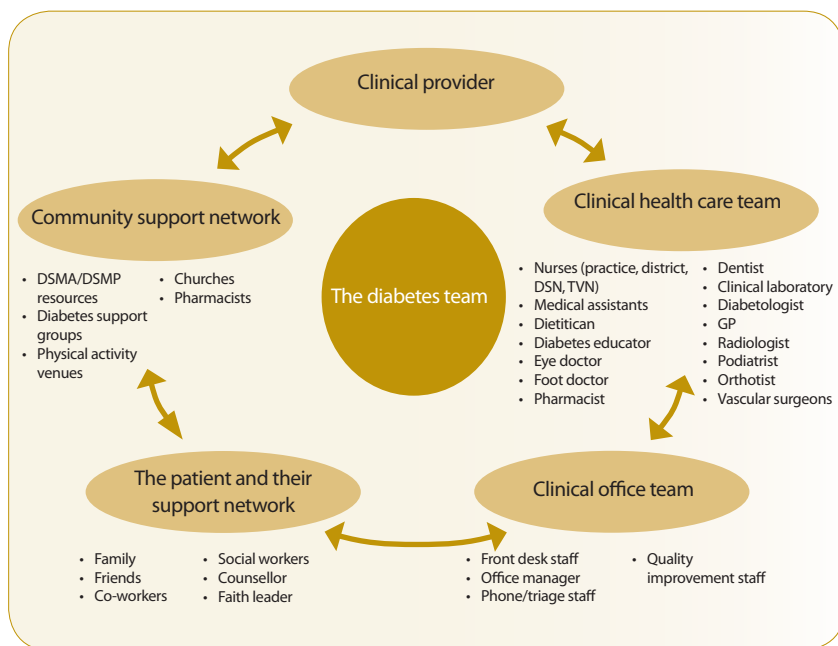


Figure 1. Collaborative support of patient-centred care.

diagnosis, comprehensive management and treatment of DFUs in the early stages is crucial.

### Multidisciplinary team approach to care

Diabetes is a complex condition and the management of DFUs requires input from a wide range of clinical specialities [Figure 1]; World Union of Wound Healing Societies [WUWHS], 2016). The multidisciplinary team (MDT) approach to ulcer and amputation prevention has been well-documented in medical literature, aiming to improve quality of life and decrease cost (Yazdanpanah et al, 2015) and has been shown to reduce amputations rates (Krishnan et al, 2008;

Tseng et al, 2011; Rubio et al, 2014; Wang et al, 2016).

The MDT can also include the patient — understanding the patient’s priorities provides an opportunity to ensure that the patient recognises that they have a role to play in treatment and outcomes (Dunning, 2016; Chadwick and Armstrong, 2017) .

### Diabetes and DFU management

Within the MDT approach, diabetes management requires individualised and comprehensive treatment targets for the prevention of complications (e.g. appropriately controlled blood glucose, blood pressure and lipid profile, and weight management, smoking cessation, healthy diet and increased physical activities). There should also be a strong focus on patient self-management and empowerment.

The goal of DFU treatment is to achieve rapid wound closure to prevent serious downstream consequences, such as reduced quality of life and amputation. Treatment should occur in a stepwise approach [Figure 2]. To fulfil standards of care, a MDT is needed at each level of DFU management. According to the IDF (2017), preventative measures should be taken early in the DFU process:

- To protect the diabetic foot from breakdown
- To prevent foot ulceration
- To avoid lower limb amputations.

### Role of surgery in the MDT

Part of the MDT is the surgical team; Luca Dalla Paola began by providing the historical context of diabetic foot surgery. In 1928,

Elliott Joslin, the first doctor in the United States to specialise in diabetes, was pioneering the MDT approach, as well as the prompt treatment of foot infections with specialised surgical care (Sanders et al, 2010). This approach continued over the next 70 years, with amputation considered as a last resort. In 1992, the importance of restoring foot perfusion to avoid DFU amputation cemented the link between the vascular surgery and podiatry care, so vascular surgeons became part of the MDT approach (LoGerfo et al, 1992).

Over the past 10 years, the surgical approach to DFU management has become more conservative, with goals to treat deformities that may increase the risk of ulceration, and to treat the ulcer or infected

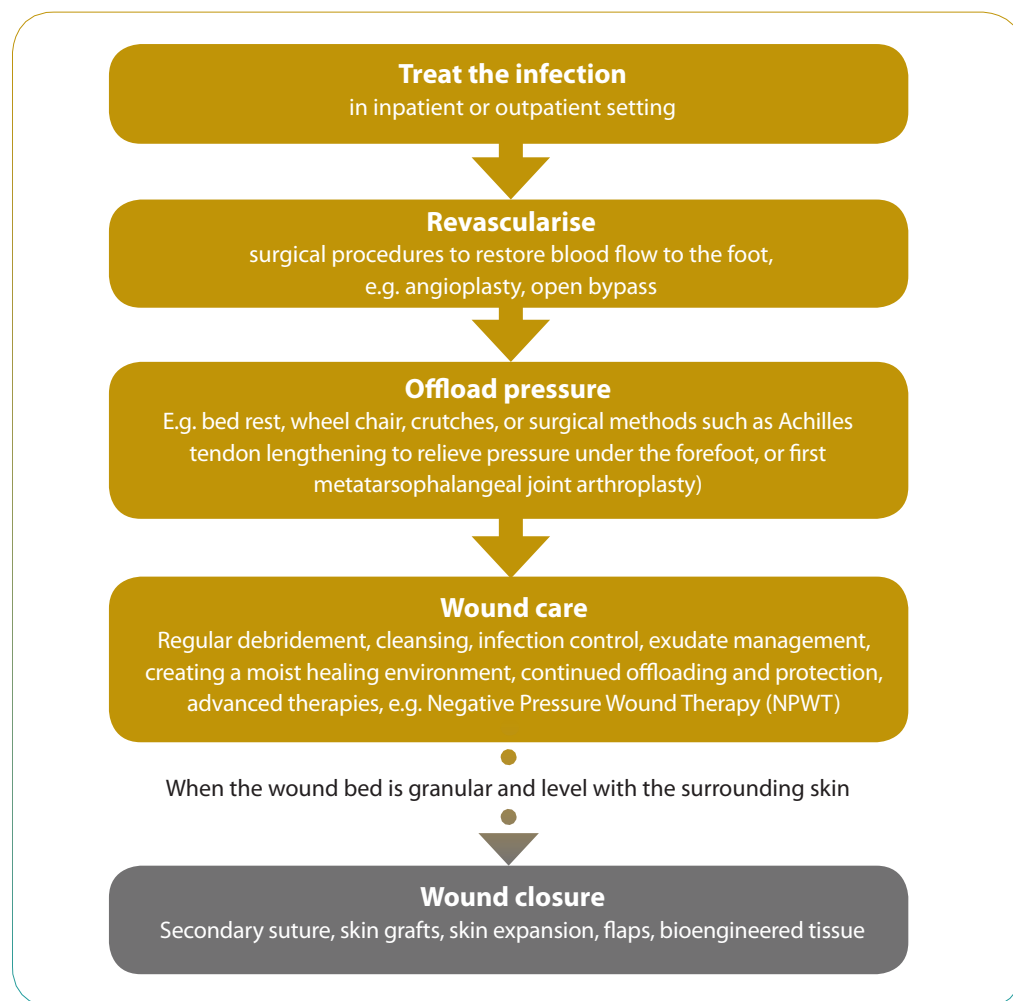


Figure 2. DFU management and treatment should occur in a stepwise approach.

site. There are many points on the progression from neuropathy to amputation where surgery can be performed to reduce the risk of future complications. There are four classes of surgery that can be used prophylactically [Figure 3], and a patient may often require two or three surgeries to reduce the risk of future complications.

Luca Dalla Paola described the MDT clinic at the Maria Cecilia Hospital, Italy, which comprises an outpatient clinic, limb salvage department, ICU, operating theatre and catheterisation lab. The diabetic foot department also works with the cardiovascular surgery team as diabetic foot is a marker of cardiac disease. The clinic carries out many procedures with the goal to avoid amputation, for example:

- Relief of plantar pressure in the treatment of neuropathic plantar ulcer
- Revascularisation procedures
- Emergency treatment of infected diabetic foot

- Surgery of the chronic diabetic foot (osteomyelitis)
- Surgery of instability and deformity (Charcot foot)
- Advanced local therapy (e.g. Negative Pressure Wound Therapy [NPWT], bioengineered tissues).

As a result of this surgical approach to diabetic foot, there has been an increase in limb salvage rate using sparing foot surgery, and a reduction in the percentage of major amputations, minor amputations and toe, ray or conservation surgeries. This is alongside a reduction in midtarsal surgeries from 2009–2014.

#### Future of diabetic foot care

Luca Dalla Paola closed his session by considering the future of diabetic foot care. The first step will be to standardise the surgical approach in terms of patient selection, timing, surgical tools, post-

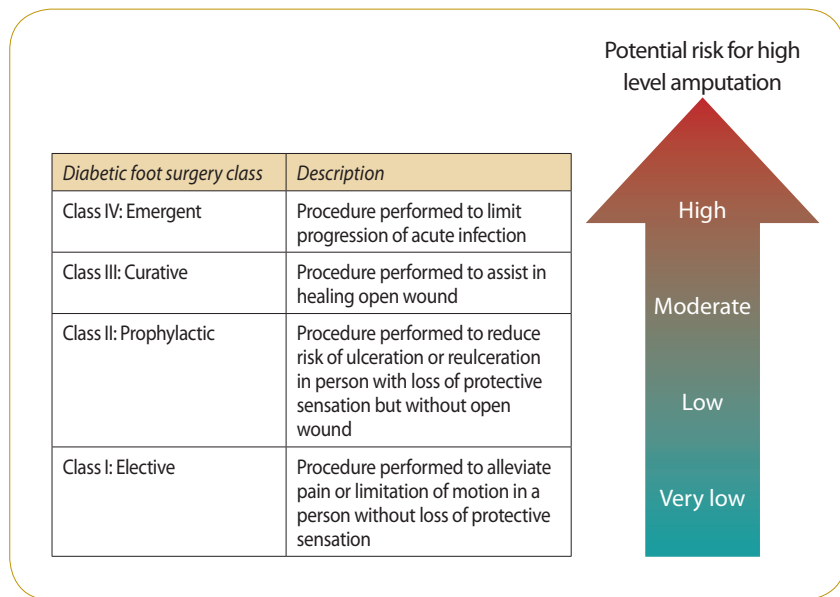


Figure 3. Diabetic foot surgery classification (Armstrong et al, 2003).

**Box 1.** Situations where surgery is mandatory for DFIs (Lipsky et al, 2012).

- DFIs with gas on the deep tissues
- For draining abscesses and purulent collections
- Open fistulous tracks
- Necrotising soft tissue infections
- When infection spreads quickly and produces an extensive tissue loss
- Infections located at midfoot and rearfoot joints (specially associated with Charcot foot).

op offloading, antibiotic treatment and technical setting.

### An integral approach to diabetic foot infections

To close the symposium, José Luis Lázaro Martínez focused on how surgery can be used to reduce the likelihood of amputations, specifically following diabetic foot infections (DFIs). Over half of patients with a DFU will develop an infection, and a quarter will experience an amputation due to the infection. An infected DFU is also estimated to be four times as expensive to treat as a non-infected DFU (Peters et al, 2016).

The modern surgical approach to DFIs should consider ulcer severity and desired outcomes, and should aim to decrease healing time, avoid amputations and decrease mortality [Figure 4]. Systemic antibiotics (oral or parenteral) are the mainstay of DFI treatment and topical antimicrobial agents, such as cleansers or dressings, are sometimes used in mild infections (Lipsky et al, 2012; Chadwick and Armstrong, 2017).

### First and second approach: Surgery

Before initiating surgery, the causes of infection must be determined. The IDSA guidelines are a recognised tool to classify DFIs (Lipsky et al, 2012) and can help determine whether surgery is required [Box 1]. The first approach to surgery is to remove all non-viable and infected tissue to stop the infection spreading. The second

approach, or revision surgery, involves deciding whether the ulcer should be closed by primary or secondary intention. DFUs are mostly closed by secondary intention, where NPWT can be a useful adjunct to create an environment to promote healing (Meloni et al, 2015).

### Third approach: Managing chronic inflammation

Normal wound healing is a four-stage process (haemostasis, inflammation, proliferation and maturation); however, non-healing wounds can often stall in the inflammation stage interrupting the normal healing trajectory of a wound (Zhao et al, 2016) [Figure 5]. Proteases, e.g. matrix metalloproteinases (MMPs), are expressed during the inflammation stage and play key roles in the wound healing process; however, there is excessive expression and activation in chronic, slow-healing wounds (Page-McCaw et al, 2007). While proteases are not the only reason for chronic inflammation and non-healing, managing elevated proteases and elastases with protease-modulating treatments along with appropriate standard of care may help to reset the wounds on a healing trajectory and improve healing rates (Lazaro et al, 2016). Optimal wound management following inflammation to stimulate wound healing includes rebalancing and maintaining a moist wound environment, reducing microbial burden or biofilms, and lowering protease activity of the host or bacteria (Gibson et al, 2009).

PROMOGRAN™ Protease Modulating Matrix and PROMOGRAN PRISMA™ Wound Balancing Matrix (KCI, An Acelyty Company, Athlone) are protease-modulating matrix dressings comprising 45% oxidised regenerated cellulose (ORC) and 55% collagen (PROMOGRAN PRISMA™ Matrix also contains 1% Silver-ORC, which contains 25% w/w ionically bound silver). The dressings have been shown to reduce protease activity, including MMPs (Lobmann et al, 2006) and human neutrophil elastase (Smeets et al, 2008), and has been shown to reduce wound area (Vin et al, 2002; Wollina et al, 2005; Kakagia et al, 2007) and shorten healing time (Lázaro-Martinez et al, 2007) for DFUs and venous leg ulcers.

Chronic inflammation and infection both prevent healing (Zhao et al, 2016). The TIME (Tissue, Infection/Inflammation, Moisture balance, Edge of the wound) concept

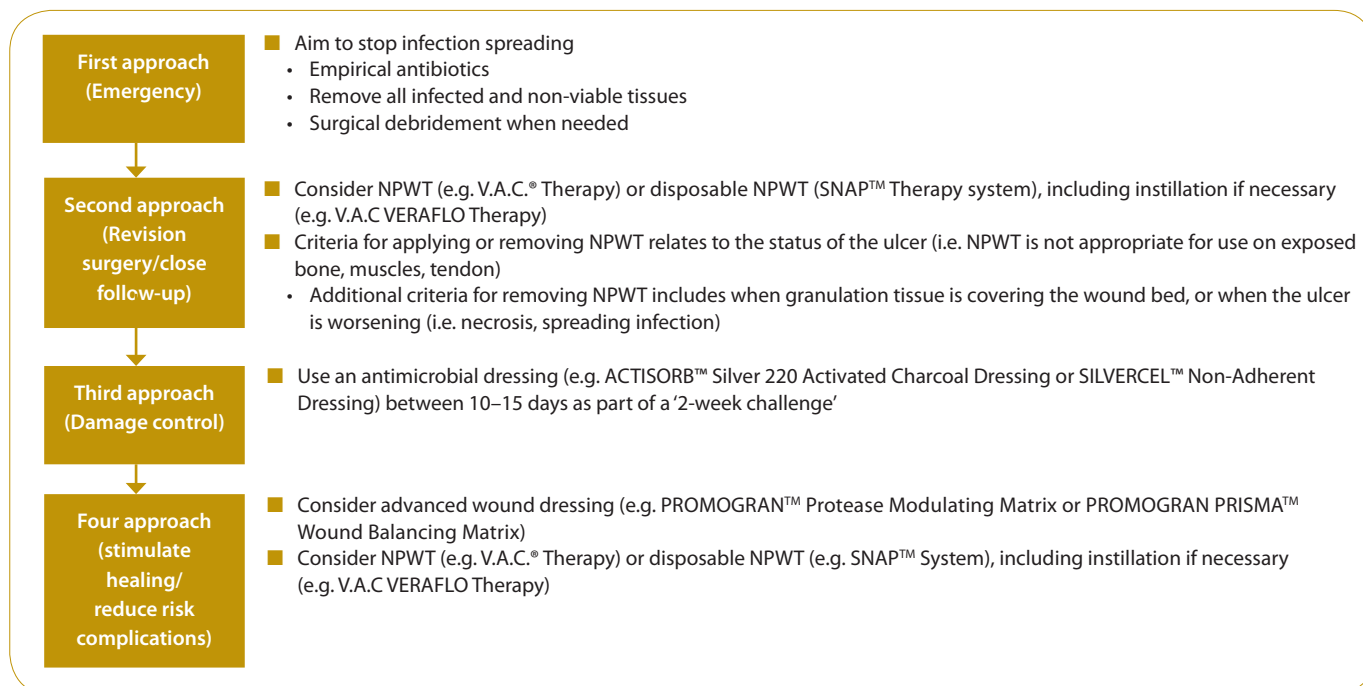


Figure 4. Modern integrated approach to diabetic foot care. NPWT=Negative Pressure Wound Therapy. All products are KCI, An Acely Company, Athlone.

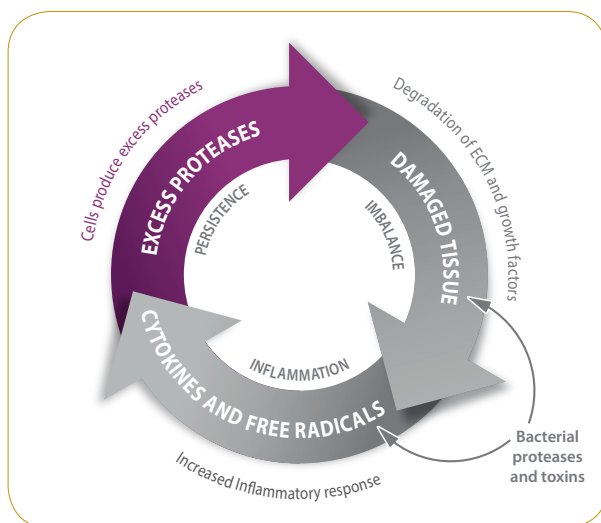


Figure 5. Non-healing wounds often stall in chronic inflammation (Gibson et al, 2009).

of wound bed preparation identifies the control of infection and inflammation as key barriers to healing, which must be overcome as part of a holistic care plan (Dowsett and Newton, 2005).

#### Fourth approach: Stimulate healing with advanced wound dressing

Once infection has been resolved or is under control, advanced wound dressings can be implemented. NPWT comprises the controlled application of sub-atmospheric pressure to the local wound environment, usually via a porous, foam interface that is placed into the wound and a semi-occlusive dressing that

overlays the interface and seals the wound. NPWT is an adjunctive therapy appropriate for acute and chronic wounds, dehisced wounds or amputation sites. It can also be used post-surgically when patients have some degree of peripheral vascular disease.

NPWT has been available for inpatients for some time (e.g. V.A.C.® Therapy; KCI, An Acely Company, Athlone), and now portable, disposable NPWT systems are available to continue care outside of the hospital setting. The single-use SNAP™ Therapy system (KCI, An Acely Company, Athlone) has been cleared for management of wounds that would benefit from the use of NPWT to promote healing through the removal of small amounts of exudate, infectious material, and tissue debris. The SNAP™ System is lightweight and quiet as it is mechanically powered, rather than electrically powered.

NPWT has an important role to play in the management of DFUs (WUWHS, 2016), and can be used to aid healing following DFU surgery (Lerman et al, 2010; Meloni et al, 2015) as a second-line treatment.

#### Conclusion

A paradigm shift is urgently needed to treat DFUs preventatively, and a MDT approach to DFU care including prevention, prompt diagnosis, education and treatment can achieve this. All members of the MDT have a shared goal to treat DFUs and achieve rapid

## Key points

1. A multifaceted approach for the management of diabetic foot ulcers (DFUs) requires a continuation of care provided by the multidisciplinary team.
2. Surgery is playing an ever-increasing role in diabetic foot management and treatment.
3. An integrated structured approach, including surgery, can reduce DFU complications, diabetic foot infections, and amputation rates, which would lead to reduced economic and patient costs.

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wound closure. To fulfil standards of care for diabetic foot, a range of clinical specialities is required, including the patient. An integrated structured approach, including surgery, can reduce DFU complications and amputation rates, which would lead to reduced economic and patient costs.

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