THE DIABETIC FOOT ISSUE

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The cost of wounds

In this issue of Wounds International, the focus is on the diabetic foot ulcer, and there are a number of interesting articles included by authors from different countries offering a global perspective on the topic. Prevention and protection is the priority for all wounds, and it is of paramount importance that efforts are made to care for the foot and avoid skin damage. Foot care may include the management of fungal infection, which is addressed in Paul Chadwick’s “ten top tips” on page 12. Paul explains that fungal infection will only be cured with intervention, and discusses the choice of treatments available.

We are delighted that Benjamin Lipsky from the US has written the guest editorial for this issue on page 4, and he discusses where we are now in relation to diabetic foot infection. He notes that “foot infection is the most common and costly complication of diabetes”.

Cost-effective wound care

In June 2013, Wounds International held a consensus meeting with the intention of looking at the costs of wounds and the importance of wound prevention and management, with a need to make the case for cost-effective wound care. There is no doubt that this is an important topic.

Dr Douglas Queen, who co-chaired the meeting, stressed that:

“In most geographies, hundreds of thousands of patients experience the debilitating effects of acute and chronic wounds every day, costing global health systems billions of dollars annually. This wound epidemic is a growing problem that needs to be addressed immediately if we are to control both global and national healthcare costs.”

It is suggested that, in order to contain costs, we must recognise and address the need for specialist involvement to avoid the ongoing financial burden associated with wound chronicity.

The document will present clear guidance on what is meant by cost effectiveness and how to make an accurate and appropriate case for cost-effective wound care, enabling clinicians to make sensible decisions around treatment choices. The meeting generated lots of debate, discussion, and sharing of experiences. The document, however, will show that there is nothing straightforward about health economics, and although the problems of cost effectiveness are not exclusive to wound healing, there are, nonetheless, specific challenges in quantifying and qualifying the costs of wounds.

The message is clear that when making a business case there are multiple factors to consider, and the key is to have access to reliable data to support the arguments presented. The consensus group stressed that one of the critical components in promoting cost-effective wound care is for clinicians to universally adopt and practice effective wound management protocols. With immense pressures on clinicians to justify the costs of care and the need to make difficult choices in relation to resources, the project is timely and was well supported by key opinion leaders and industry. This international document on cost effectiveness will be available from the Wounds International home page at the end of November 2013.

Global wound care

As this issue goes to press, the Wounds International team will be in Malaysia where we are delighted to be working with Dr Harikrishna and the Malaysian Society of Wound Care Professionals in delivering the “Global wound care made local” conference on 18–20 October 2013 in Kuala Lumpur. The programme includes presentations on the costs of wounds, as well as many interesting innovations, such as the role of stem therapy and growth factors in healing. It has been a privilege for us to work with the Malaysian Society of Wound Care Professionals and we see this event as pivotal in developing our reach to the Asian-Pacific region.
What I would most like to learn about managing diabetic foot infections

Diabetic foot infections are among the most common and costly complications of diabetes. In his guest editorial, Benjamin A. Lipsky considers the answers to questions relating to the diagnosis of causative pathogens, the effectiveness of topical antimicrobial therapy for mildly infected ulcers and the most appropriate way to treat diabetic foot osteomyelitis.

In 1987, my colleague Roger Pecoraro, a diabetologist with whom I worked in a primary care clinic, asked me to see a patient with diabetes and a nasty foot infection. “As an infectious diseases specialist, how would you suggest I treat this?” he asked. After providing some generic advice I went to the library (that place people went in the pre-internet era) and looked for textbooks and articles on diabetic foot infection. I was surprised to find remarkably little data; the few published investigations made pronouncements like “as is” apparent from this study, antibiotic therapy does not eradicate the organisms in the deep tissue, and surgical procedures are usually required for definitive treatment.”

The textbooks suggested that these infections were nearly always polymicrobial, that all patients needed to be hospitalised and that they should be treated with broad-spectrum, parenteral, and prolonged antibiotic therapy. As this differed from our experience, we conducted a prospective, randomised trial comparing two relatively short-course oral antibiotic regimens in patients treated in the ambulatory setting. Our results suggested that almost all of the published advice was largely wrong.

Flash forward 25 years and there are now approximately 2200 papers listed on PubMed on “diabetic foot infections”, with many guidelines based on systematic reviews of this literature. We now know that:

- Acute infections in patients (at least in northern countries) who have not recently had antibiotic treatment are usually caused by only aerobic Gram-positive cocci (predominantly Staphylococcus aureus).
- Those infections that are mild or moderate in severity can be treated with a week or two of oral (and occasionally even topical for mildly infected ulcers) antibiotic therapy in the outpatient setting.
- Lower-extremity amputation is usually avoidable.

So, what’s left to learn about foot infections, now among the most common and costly complication of diabetes? Here are the three questions that I would most like to have answered.

1. What’s the best way to determine the causative pathogens in diabetic foot infections?

All open wounds are colonised with microorganisms, but we believe only those causing host damage need to be treated. Deciding which among the isolated organisms are pathogens starts with obtaining an appropriate specimen from the wound. While swab cultures are easy to obtain, the few small, suboptimal published studies suggest that, compared with tissue specimens, they often contain colonisers (i.e. are non-specific) and fail to grow fastidious and anaerobic organisms that are potential pathogens (i.e. are insensitive).

An ongoing large, multicentre, prospective study in the UK that is comparing these two types of specimens from infected diabetic foot wounds should soon provide some useful data. Another approach that will soon help answer this question is the use of the rapidly emerging molecular microbiological methods to quickly determine which organisms in a wound have genes for virulence factors, as well as for antibiotic resistance.
Embarrassed by visible strikethrough, worried by knocks and bumps, frustrated by dressings that refuse to stay in place; for people with chronic wounds, hiding at home can feel like their only option.

At Smith & Nephew our observational research revealed all the reasons why living with a chronic wound stops people living the life they want to lead.

The results inspired us to create ALLEVYN Life, a dressing specially designed to help people with chronic wounds regain their freedom, positively impacting on patient wellbeing.

Find out how ALLEVYN Life can help you bring your patients out of hiding
Visit: www.allevynlife.com
2. Is topical antimicrobial therapy effective for mildly infected ulcers?
Topical therapy has many potential advantages, including providing high local antibacterial concentrations without the possible adverse effects of systemic levels of the drug[8]. Furthermore, agents that are potentially toxic when used systemically may be safe when administered topically. Finally, non-antibiotic antimicrobials can be used topically, avoiding overuse of antibiotic agents that are needed for systemic infections, thus reducing the pressure driving antibiotic resistance. There have been few studies of topical antimicrobials for diabetic foot infections[9], but several are now in the process of obtaining approval for prospective randomised trials. We should have more information about the role of this route of administration in the next few years.

3. What is the most appropriate way to treat diabetic foot osteomyelitis?
Surgical resection of all necrotic and infected bone has been the traditional approach to treating chronic osteomyelitis, but in recent decades evidence is mounting that antibiotic therapy alone may be sufficient to eradicate many of these infections[10]. Due to concern for limited penetration of antibiotics and a lack of antibacterial phagocytes in bone, intravenous therapy has generally been used for osteomyelitis.

In the UK, an ongoing large, multicentre trial[11] is comparing parenteral with oral antibiotic therapy for treating various types of complex musculoskeletal infections, including diabetic foot osteomyelitis; results should be available within a year, providing an answer to this important question.

Improving outcomes
These and many other questions need to be addressed to ensure we provide optimal care for patients with diabetic foot infections. We have come a long way in improving outcomes, but there is much for those of us interested in this field to do to enhance management of this important and growing problem.

References


Diabetic foot

Changes in the biomechanics of the foot, resulting in pressure redistribution, are known risk factors for ulceration of the diabetic foot. Footwear is the most common intervention for biomechanical abnormalities of the foot. Custom-made or commercially available insoles in retail shoes, or in combination with therapeutic shoes, have been proposed as methods of reducing abnormal foot pressures and thus ulceration in the diabetic foot.

An understanding of the biomechanical changes seen as a result of diabetic neuropathy – and its impact on risk of ulceration – is instructive for those involved in the management of the diabetic foot. The role of footwear in ulcer prevention at all levels of diabetic foot ulcer risk is also discussed.

BIOMECHANICAL ALTERATIONS COMMON TO THE DIABETIC FOOT

An investigation of the biomechanics of the foot are informative in understanding how changes to the foot’s structure, and the resultant alterations in gait, are associated with the risk of ulceration in the diabetic foot.

Motor neuropathy is responsible for a progressive atrophy of the intrinsic muscles of the foot that may result in a variety of foot deformities, including hammer or claw toes, hallux valgus and prominent metatarsal heads. These deformities of the foot result in areas of increased plantar pressure and among people with diabetes are known to increase the risk of foot ulceration[1].

Limited joint mobility, especially at the ankle and at the first metatarsal joints, contributes to the onset of increased plantar pressures associated with ulceration. Limited joint mobility in all planes and directions of movement can be read as a consequence of stiffness at those joints which mainly manage the foot–floor interaction during gait. In turn, increased stiffness at the ankle and first metatarsal joint interferes with the correct foot loading pattern, preventing the correct downloading of the metatarsal heads during push-off. The poor inversion/eversion movement confines the progression to the sagittal plane. As a result, the metatarsal heads undergo a greater and longer loading, which may contribute to the onset of ulceration[2].

Some people with diabetes are known to have increased thicknesses of the plantar fascia. A relationship between plantar fascia thickness and increased forefoot vertical forces, and thus plantar pressure, has been established. This finding supports the hypothesis that soft tissue abnormalities contribute to the development of an altered distribution of pressure under the foot[3].

As a result of the concurrent action of all the above factors (i.e. intrinsic/extrinsic musculature imbalance, joint stiffness, thickening of tendons and ligaments) people with diabetic neuropathy may develop rigid feet that are less adaptable to the floor. In these circumstances, the foot remains rigid during the whole walking cycle, leading to high plantar pressures under the metatarsal heads[3].

The association between biomechanical change, foot deformity and sensory neuropathy results in a foot that experiences increased plantar pressures, increased friction with footwear and lacks protective sensitivity to mechanical stress and potentially harmful objects and circumstances. Under these circumstances, the person with diabetes is at increased risk of ulceration.

FOOTWEAR AND BIOMECHANICS

Shoes interfere with the performance of natural gait (i.e. that performed by a healthy person while walking barefoot). While walking in shoes, a “normal” – rather than “natural” – gait, with the aim of moving the body forward in space while taking into account the constraints from the use of shoes, can be achieved[4].

Shoe heels result in the rear-foot assuming a greater inclination with respect to the ground than is seen barefoot [Figure 1]. This elevation of the heel results in faster unloading of the rear-foot during walking, and a
greater loading of the metatarsal heads. The higher the heel, the greater the alteration of the loading pattern. Increased heel height also results in a shortening of the Achilles tendon, and thus a power reduction in those leg muscles involved in propulsion. Likewise, the shoe tip is usually 1.5–3.0 cm lifted from the ground. Thus, during walking in shoes, the toes are partially prevented from taking part in propulsion, resulting in a greater involvement of the metatarsal area.

Even more critical is the concavity of the sole under the metatarsal heads, which causes the foot as a propulsive lever to act under adverse conditions. During barefoot walking, the foot flexes >50° at the metatarsal level, while flexion of conventional shoes ranges between 10° and 40°. The less flexible the shoes, the less normal the gait. In low flexibility shoes, a flat-foot gait can be observed, with propulsion phase being focused under the metatarsal heads.

Most conventional shoes are made with a certain flaring, while healthy feet are characterised by a longitudinal straight line. From a biomechanical point of view, this represents a constraint for the performance of the natural helicoidal movements of the foot during gait. Narrow shoes prevent the natural widening of the foot during contact with the ground, resulting in greater loading of those areas that are involved in foot–ground contact. Conversely, overly large shoes may lead to undesirable friction between foot and shoe sole. Even in well-fitted shoes the foot–ground contact may be as little as 50% of the natural barefoot footprint.

The thicker the sole of the shoes, the more pronounced the reduction of the sensory response of the foot. This lack of tactile contact with the ground weakens the reflex action of foot and leg muscles, resulting in a less safe gait. This can be of particular concern for people at risk of falls.

ROLE OF FOOTWEAR IN THE MANAGEMENT OF THE DIABETIC FOOT

In the presence of diabetic neuropathy, footwear can play a critical role in the pathogenesis of foot complications. Thus, footwear for people with diabetes should not increase the risk of complications and, ideally, also serve as a form of protection. In general, suitable footwear and insoles for people with diabetes should:
1. Reduce abnormal pressure;
2. Limit the formation of callus and ulcers; and
3. Protect from external trauma.

Furthermore, the lifestyle of the person being recommended the shoes should be taken into account, especially with regard to their level of activity.

FOOTWEAR AND ULCER RISK

People with diabetes, at any given time in the natural history of their condition, will experience some level of foot ulcer risk. Measures of risk usually take into account the presence or absence of protective sense perception, presence or absence of vascular disease, significant foot deformities and previous foot ulceration or amputation.

One common measure of diabetic foot ulcer risk is the University of Texas classification scheme. In this scheme, diabetic feet fall into one of four categories of ulcer risk: low, medium, high or very high.

The level of ulcer risk experienced by a person with diabetes should be taken into account when choosing footwear. In the following four sections, the authors provide their guidance on the types of footwear appropriate for each level of ulcer risk (summarised in Table 1).

Low risk

People with diabetes who have normal sensation, no foot deformities and no history of ulceration or amputation can be classified as being at low risk of ulceration. At low level risk, priorities should be protecting sensation and education for self-care and prevention.

No real change in footwear is necessary at this level of risk. However, people in this category might be encouraged to consider the following when selecting footwear:
- Footwear that is well-fitted and wide enough in the forefoot will avoid friction that can lead to blisters, corns or callus.
Soft, preferably heat-sensitive, uppers should be preferred for the same reasons.

Shoe soles should be selected for their efficiency in absorbing vertical forces, thus rubber, wide and flexible soles are preferable to leather board soles.

Tight-fitting footwear with narrow forefoot, tight toe box or tight instep should be avoided.

Medium risk
The development of diabetic neuropathy, with the ensuing loss of protective sensation, places people with diabetes at increased risk of ulceration. No prospective studies have yet satisfactorily assessed the effectiveness of footwear in primary prevention of diabetic ulceration. Despite this, clinical experience and some observational studies suggest that well-fitting shoes can play a role in protecting neuropathic diabetic feet from ulceration.

Before choosing shoes at this level of risk, the foot should be accurately measured in all its dimensions, and a shoe chosen that accommodates insoles in all dimensions.

Soft, preferably heat-sensitive, uppers should be selected. Shoe soles should be selected for their efficiency in absorbing vertical forces; rubber, wide and flexible soles are preferable to leather board soles.

Tight-fitting footwear with narrow forefoot, tight toe box or tight instep should be avoided.

Table 1. Suggestions for appropriate footwear for people with diabetes in relation to the individual’s risk of ulceration (based on the University of Texas scheme).
barefoot, even in the home, should be discouraged. Mended socks should be avoided. People with diabetes and a medium or greater risk of ulceration should be encouraged not to wear the same pair of shoes for prolonged periods. Frequent changes of footwear result in less stress on discrete areas of skin that may ultimately reduce the risk of ulceration at that point.

**High risk**

When the neuropathic diabetic foot is complicated by foot deformities (e.g. bunion, claw toe, hammer toe) the risk of ulceration increases. Foot deformities, frequently of the toes, often confer biomechanical changes that result in abnormal gait followed by the appearance and persistence of overloading at the metatarsal level in the propulsion and toe-off phases of walking. In these areas of overload, hyperkeratosis can be followed by ulceration.

A recessed heel, allowing a softer impact at heel strike should be included in shoes for this group. An increased reduction in pressure can be achieved with the use of a rigid or rocker-bottom sole, which minimises the metatarsal–phalangeal joint articulation tension and maximises foot contact area during late stance phase. This kind of shoe induces a modification in the walking pattern and may cause pain in the muscles at the back of the lower leg as they begin to bear a greater load, but has been shown to significantly reduce the number of calluses when compared with retail footwear after 12 months’ wear. When designed with a point of the roll of the step placed immediately behind the metatarsal heads, such shoes reduce peak pressure by up to 30%.

A further reduction up to 20% is gained by the use of customised insoles.

Therapeutic footwear with insoles (e.g. microcellular rubber, polyurethane foam, moulded insoles) have been shown to reduce plantar pressures and ulcer recurrence when compared with retail shoes with leather board insoles. Total-contact insoles can reduce pressure peaks by maximising the insole device–foot contact area, and custom-made, rather than flat, insoles have been shown to be more effective in offloading the first metatarsal head region.

Special care should be taken using insoles in retail shoes. If the shoe is not designed to accommodate the addition of an insole, the insertion of one will reduce the space available to the foot and increase friction. To avoid this, measure the depth of the foot at the level of the metatarsal heads, add the thickness of the insole to this measurement, and compare this figure with the inside depth of the shoe at the corresponding point. Ideally, the shoes should have soft, preferably heat-sensitive, uppers that enable comfortable accommodation of any foot deformities in addition to insoles.

The use of commercial available therapeutic, rather than custom-made, footwear offers a number of advantages, primarily the ease and speed of access (a stock can be kept in the clinic) and a reduction in cost per unit in comparison with custom-made products.

**Very high risk**

People with diabetes, neuropathy, foot deformity and a history of ulceration or amputation are at very high risk of ulceration. People in this group experience a 50% rate of ulcer recurrence within 12 months of healing. Those at very high risk of ulceration are known to have abnormally elevated plantar pressures during walking, with the areas of peak pressure frequently occurring under the metatarsal heads and correlating with sites of callus and, ultimately, ulceration.

In contrast to the primary prevention of diabetic foot ulcers, various studies have demonstrated a protective role for footwear in secondary prevention, for both custom-made and prefabricated commercially available shoe models with the use of insoles. More than 20 years ago, Edmonds et al. reported an ulcer relapse rate of 26% among those who wore custom-made therapeutic footwear, and 83% among those who wore retail shoes. The first author’s own research found similar relapse rates to be associated with therapeutic shoes with custom-made insoles (28%) versus retail footwear (58%).

In 2003, Busch and Chantelau assessed the efficacy of commercially available therapeutic shoes and insoles and found that 15% of people wearing this combination ulcerated 12 months after healing, while 60% in retail shoes ulcerated in the same period. Striesow tested commercially produced therapeutic shoes, according to Tovey’s guidelines, and observed similar results.

Recommendations for the selection of footwear for this group are as outlined in the high-risk category, in particular footwear with rigid or rocker-bottom soles and moulded insoles. Multilayered, moulded insoles are preferable at this level of risk as they provide the greatest reduction in peak pressures.

**CONCLUSION**

Epidemiological surveys indicate that between 40% and 70% of lower-limb amputations worldwide are diabetes related, and around 85% of these are preceded by foot ulceration. Thus, the prevention of diabetic foot ulceration is a clinical priority.

Footwear plays a key role in diabetic foot ulcer risk. Indeed, unsuitable or ill-fitting footwear can insufficiently protect the insensate foot from trauma that may precipitate ulceration, or be itself the cause of trauma that progresses to ulceration. Conversely, correctly fitted therapeutic shoes and insoles may protect the at-risk
foot from trauma and redistribute plantar pressures, thus protecting it against ulceration. Research suggests that the importance of footwear in diabetic foot ulcer prevention increases with the increasing level of ulcer risk experienced by the individual. However, prospective studies that have been carefully designed and carried out in large populations are needed to confirm the role of footwear in diabetic foot ulcer prevention.

It is important that clinicians are aware of the importance of giving footwear advice to all people with diabetes. Especially for those with neuropathy, the selection and use of suitable footwear may represent a valid means of diabetic foot ulcer prevention.

REFERENCES

Clinical manifestations of fungal infections are named according to the location of the site infected; for example, tinea barbae is a fungal infection of the beard, tinea cruris is a fungal infection of the groin (jock itch), and tinea favosa is a fungal infection of the scalp (crusty hair). Within the foot, we are faced with two common appearances: tinea pedis (athlete's foot); and tinea unguium (infection of the nails). The more recognised term for a nail infection is onychomycosis.

Tinea pedis and onychomycosis have a similar prevalence of about 15–20% of the population, and they often co-exist\textsuperscript{[1,2]}.

Prevalence is usually higher in males and where people live in close proximity, such as a college campus or military camp.

Tinea pedis presents as pruritic, erythematous, inflamed regions on the feet that may be located between the toes (interdigital type \textsuperscript{[Figure 1]}), on the sole (vesicular type), or on the medial and lateral aspects of the foot (moccasin type \textsuperscript{[Figure 2]}).

The most common fungi that cause tinea pedis are \textit{Trichophyton rubrum} (80%) and \textit{Trichophyton interdigitale} (15%);\textsuperscript{[3]} others that may be seen less often include \textit{Epidermophyton floccosum} and \textit{Microsporum}.

Commonly, but not always, tinea pedis presents alongside onychomycosis, resulting in dystrophic and discoloured toenails.

Fungal infections are contagious, and without treatment can spread to both feet and every toenail; furthermore, they can spread between individuals.

As the fungi that cause athlete's foot require warmth and moisture to survive and grow, the primary method of incubation and transmission is when people who regularly wear shoes go barefoot in a moist communal environment, such as a changing room or shower, and then put on shoes. Transmission is host to host through infected squames; squames are flat, keratinised, dead cells shed from the outermost layer of a stratified squamous epithelium. The source is either directly from people with chronic infections or from long-lived arthrospores that reside in squames deposited in shoes, flooring, and carpets (fomites).

True nail infections with yeasts, such as \textit{Candida albicans}, are rare and more likely to affect the finger nails\textsuperscript{[4,5]}. Rarely, they may also cause paronychia, which is inflammation and infection where the nail meets the skin\textsuperscript{[6]}.

**How to...**

Ten top tips on managing fungal infections of the diabetic foot

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**Figure 1. Interdigital tinea pedis.**

**Figure 2. Moccasin-type tinea pedis.**

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Fungal infections in the normal population can be uncomfortable and cosmetically unpleasant. However, they are unlikely to cause any serious complications. In people who are immunocompromised or at risk of foot complications, such as people with diabetes, there is an increased risk of developing secondary complications, such as bacterial infections, foot ulceration, paronychia, cellulitis, and an increasing risk of lower limb amputation[6,7]. Therefore, the prevention, identification and management of fungal foot infections in these individuals is particularly important.

Ten top tips on managing fungal infections of the foot

1. **Suspect fungal infection whenever the nail looks abnormal**: Colour and dystrophy are the most important clues to diagnosis. Presentations include:
   - Lateral onychomycosis, where white or yellow opaque streaks appear along one side of the nail.
   - Distal onycholysis and hyperkeratosis, where scaling occurs under the distal nail; the nail is discoloured, opaque and thickened and, as a result, the end of the nail lifts up.
   - Superficial white onychomycosis, where small, flaky, white patches and pits appear on the top of the nail plate; the nail becomes roughened and crumbles easily.
   - Total dystrophic onychomycosis, where the nail is completely destroyed.

2. **Presentation of tinea pedis**: Tinea presents as pruritic, erythematous, and inflamed regions of the foot, commonly:
   - Between the toes (interdigital).
   - On the medial and lateral aspects of the foot (moccasin type).

3. **Guide to when a sample should be taken for a fungal infection**[6,7]:
   - When oral therapy is being considered, usually for nail disease.
   - In severe or extensive skin fungal infections, such as in moccasin-type athlete’s foot (note that samples are NOT needed in uncomplicated athlete’s foot).
   - Where a secondary bacterial infection is suspected.
   - When there is diagnostic uncertainty.
   - In at-risk groups, such as people with diabetes.

4. **How to take a skin or nail sample**[8,9]: The following steps must be taken when taking a skin or nail sample:
   - Wipe off any treatment creams, lotions, or powders with 70% alcohol before sampling.
   - For skin samples, scrape skin using a scalpel from the advancing edge of the lesion; skin flakes >5 mm² are needed for microscopy.
   - If superficial infection of the nail is suspected, use a scalpel to obtain scrapings of the surface of the nail.
   - If deeper infection of the nail is suspected, use cuticle nippers to sample the diseased part of nail.
   - When clipping the nail, include the full thickness of the nail and extend as far back from the nail tip as possible; viable fungi are most likely to be found in the most proximal part of the diseased nail. Include scrapings of debris from the area between the nail and nail bed. Denning et al[10] found that culture for fungi was more likely to be positive the nearer the sample site was to the cuticle of the nail affected by onychomycosis.
   - Keep the samples at room temperature – do not refrigerate them (dermatophytes die at low temperatures).
   - False-negative rates are high (approximately 30%). Therefore, a negative test cannot definitively exclude fungal nail infection. Repeat the test if the result is negative and there is high clinical suspicion that the nail is infected.

5. **Differential diagnosis for onychomycosis**: Many nail problems can look like fungal infection, but only 45% of dermatology samples received are positive for fungal infection[9]. The differential diagnosis for onychomycosis include[3,11,12]:
   - Onychauxis. Thickened nail, with or without ridges, often caused by trauma; trauma can be either major, such as a crush injury, or multiple, minor trauma, such as wearing protective toe caps.
   - Psoriasis. Affected nails are pitted with shallow or deep holes. The nail may be deformed, thickened, discoloured (brownish yellow), and separated from the nail bed. The skin rash associated with psoriasis is dry, red, skin plaques with silver scales. These lesions are most often found on the elbow, knee, scalp, or lower back.
   - Lichen planus. Affected nails are usually thin but they may thicken, often becoming

Page points

1. Fungal infections in the normal population can be uncomfortable and cosmetically unpleasant; however, they are unlikely to cause any serious complications.
2. In people who are immunocompromised or at risk of foot complications – such as people with diabetes – there is an increased risk of developing secondary complications, such as bacterial infections, foot ulceration, paronychia, cellulitis, and an increasing risk of lower limb amputation.
3. The prevention, identification, and management of fungal foot infections is particularly important in immunocompromised individuals.
REFERENCES


grooved and ridged; they may be discoloured and separate from the nail bed. The nails may shed, stop growing altogether or, in rare cases, completely disappear. Lichen planus has many forms and affects the skin and mucous membranes. The skin rash of the classical form has shiny, flat-topped, firm papules varying from pinpoint to larger than a centimetre in diameter; lesions are purple and often crossed by fine white lines (Wickham striae).

- **Eczema.** Affected nails are ridged and thickened; the skin is dry and redden, and itchy or painful.

- **Other diagnoses.** These include the following (not exhaustive): bacterial infection; onychogryphosis (Ram’s horn dystrophy, where the nail is thickened as a result of trauma and neglect, common in the elderly); onycholysis (separation of the nail painlessly from the nail bed); verrucae; and subungual melanoma (pigmentation extends onto the nail fold).

6 Management of fungal foot infections. Management is tailored to the fungal infection diagnosed and the part of the foot affected:

- **Dermatophyte infection of the skin; treatment is usually topical 1% terbinafine once- or twice-daily for a week**[3,5,11,12]. Terbinafine is fungicidal (kills the fungus) as opposed to fungi static (prevents fungal development). If the infection is intractable, consider oral terbinafine.

- **Dermatophyte of the nail; use oral terbinafine 250 mg once-daily for 3–6 months**[11,12,13].

- **Nail infections with non-dermatophyte moulds** (Aspergillus species) or Candida species; use oral itraconazole (given as pulsed therapy – three courses of 7 days per month). Note that liver impairment may occur with terbinafine and itraconazole.

7 Considerations for infection management in people with diabetes. People with diabetes should follow the same guidelines for foot infection management as the general population. However, Tan and Joseph[14] suggest that people with diabetes tend to be more resistant to treatment with traditional antifungal regimens because of hyperglycaemia and difficulty maintaining good foot hygiene (usually as a result of neuropathy, obesity, or retinopathy).

8 Considerations for polypharmacy. There are many potential interactions that must be considered when prescribing oral therapies for the treatment of fungal infections. Grant et al[13] identified that many people with diabetes experience polypharmacy; the risk of drug interactions must be considered, as well as increasing an already large pill burden for people with type 2 diabetes.

9 Monitor treatment progress. When a normal area of nail appears near the proximal nail fold, it is likely that the nail is responding to the treatment. Consider discontinuing treatment about 4 weeks after this normal area appears. After completing treatment, consider resampling the nail if its appearance still suggests infection, although nail appearance does not always return to normal after the infection has been cured.

10 Strategies for fungal infection prevention[3,5]:

- Maintain good foot hygiene and treat any mild tinea pedis before the infection spreads.

- Wear well-fitting shoes, without high heels or narrow toes. Keep the shoes dry; this can be achieved by not wearing the same shoes on a daily basis – it would be better to alternate them. Replace old shoes that may have become colonised.

- Wear clean, absorbent socks, preferably from natural fibres, such as cotton.

- When in communal areas, try and avoid contact with flooring by wearing slip-on shoes, such as flip-flops.

CONCLUSION

Fungal foot infections are common, and the treatment of them has improved significantly over the years. In healthy populations they cause few problems, but in individuals who have comorbidities, such as diabetes and chronic wounds, the risk of synergistic bacterial and fungal infections are high.

The need for early identification, followed up by microbiological confirmation and aggressive treatment is important in preventing these seemingly minor problems becoming a potential catastrophe. The role of prevention through the adoption of good, sensible foot hygiene should also not be overlooked.
Diabetic foot ulcer healing with a silver dressing combined with soft silicone technology

People with diabetes present a wound management challenge; in particular, foot ulcers are slow to heal and prone to infection. Mismanaged ulceration may lead to extensive tissue destruction, amputation, and impaired quality of life[1]. Most lower limb amputations are preceded by a foot ulcer, generally resulting from peripheral neuropathy, foot deformities, minor foot trauma, or peripheral arterial disease[2]. Lower limb amputation carries a 50% mortality within 5 years[3]. Even when ulcers are healed, >50% will have a recurrence after 3 years[1].

While the cost of diabetic foot ulcer management is estimated to be £13.75 billion a year in the UK[4], according to Benbow[5] the true prevalence of diabetic foot disease is unknown, which makes the potential economic and personal burden of diabetes treatment and complications inestimable.

This article presents a case report outlining the management of an individual with a diabetic foot ulcer who presented to the author’s clinic in Abu Dhabi, United Arab Emirates.

THE PATIENT
Mr W is 65 years old, retired, and mostly stays at home. He has had diabetes for 20 years and has triple-vessel disease, high cholesterol, hypertension, retinopathy, renal impairment, and neuropathy. He had also been a heavy smoker. Medications included clopidogrel and bisoprolol for hypertension. When he presented to the clinic on 18 April, he had an ulcer on the planter side of the foot, which had been present for 4 weeks. As with many of the clinic’s patients, Mr W walked barefoot most of the time; however, as a result of his neuropathy, he did not feel the burn that eventually led to the ulcer.

Approximately 570 patients with wounds are seen each month. Wound types include pressure ulcers, diabetic foot ulcers, and surgical wounds. Wound care nurses are responsible for the selection of dressings and ongoing wound management and, as such, are responsible for providing the correct dressing at the correct time to ensure that wound management is both cost efficient and clinically effective.

Wound dressing choice is based upon clinical knowledge, ensuring that the ideal requirements for a dressing are met[6] and that the dressing is the most appropriate one for the individual and the wound, with consideration of any comorbidities that the individual may have[Box 1].

THE CLINIC
The wound care unit at the Sheikh Khalifa Medical City, Abu Dhabi, is run by four nurses and is supported by members of the multidisciplinary team, including a plastic surgeon, a vascular surgeon, a pain nurse specialist, a nutritionist, a general surgeon, a physician, and a dermatologist.

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Mr W had been treated initially at a local primary healthcare clinic with Polyfax® ointment (Teva UK), gauze, and a retention bandage. Polyfax contains polymyxin B sulphate and bacitracin zinc – both of which are antibiotics – and is indicated for use on infected wounds.[7] Dressings had been changed every other day, although they had caused some trauma to the wound.

THE WOUND
At the first visit to the clinic, the wound measured 4 cm x 4.5 cm, appeared to be infected, and was producing large amounts of exudate. Areas of necrotic tissue were also noted and the periwound skin was macerated. Sharp debridement was undertaken before commencing the dressing regimen [Figure 1].

INVESTIGATIONS
Based upon the clinical appearance of the wound, a swab was taken to determine whether or not the wound was infected and to determine the causative organisms. Mr W’s blood glucose level was 19.4 mmol/L.

DRESSING
After the wound was debrided, it was dressed with Mesalt® (Mölnlycke Health Care) and Mepilex® (Mölnlycke Health Care), and secured with a bandage. Mesalt is indicated for use on heavily discharging infected wounds in the inflammatory phase. It is a gauze dressing impregnated with sodium chloride, which helps stimulate the cleansing of moist necrosis; the wound exudate releases the sodium chloride from the dressing, which then stimulates cleansing by absorbing exudate, bacteria, and necrotic material from the wound, thereby facilitating the natural wound-healing process[8]. The Mepilex dressing is a soft and conformable foam dressing that absorbs exudate and maintains a moist wound environment. Safetac® (Mölnlycke Health Care) technology prevents Mepilex from sticking to the wound bed. The Safetac layer ensures that the dressing can be changed without damaging the wound or surrounding skin, thus enabling pain- and trauma-free removal; it also absorbs exudate effectively to ensure a low risk of maceration[9].

TREATMENT PROGRESS
One week after initial clinic visit
As Mr W lived 300 km from the clinic, his wife changed the dressing at home on alternate days. He returned to the clinic on 25 April; the wound dimensions remained the same, although the periwound maceration had improved slightly. The results of the wound swab indicated a Pseudomonas infection. It was decided to use Mepilex® Ag (Mölnlycke Health Care) instead of Mepilex to manage the infection and exudate. Mepilex Ag, according to Barrett[9], incorporates the rapid and sustained antimicrobial action of ionic silver with the benefits of Safetac soft silicone adhesive technology. The combined attributes of each component of this dressing enable the control of pain and infection to be achieved simultaneously. The patient was advised to use this dressing regimen every third day.

Two weeks after initial clinic visit
When Mr W returned to the wound care unit on 2 May, the wound measured 3.5 cm x 4 cm and the periwound area was free of maceration. The exudate level was low, so it was decided to continue with this regimen, except the dressing change took place every 5 days [Figure 2]. Mr W stated that the dressing was easy to apply.

Four weeks after initial clinic visit
By the 16 May, the wound measured 2.5 cm x 3.5 cm. The dressing, which then stimulates cleansing by absorbing exudate, bacteria, and necrotic material from the wound, thereby facilitating the natural wound-healing process[8]. The Mepilex dressing is a soft and conformable foam dressing that absorbs exudate and maintains a moist wound environment. Safetac® (Mölnlycke Health Care) technology prevents Mepilex from sticking to the wound bed. The Safetac layer ensures that the dressing can be changed without damaging the wound or surrounding skin, thus enabling pain- and trauma-free removal; it also absorbs exudate effectively to ensure a low risk of maceration[9].

1. Characteristics of an ideal wound dressing[6].

- Creates microclimate for rapid healing
- Prevents dehydration (of the wound)
- Permeable to oxygen
- Absorption of blood and exudate
- Protects against secondary infection
- Offers sufficient mechanical protection to wound but is non-adherent
- Is non-toxic, non-allergenic, and non-flammable
- Does not shed material into wound
- Conforms to anatomical contours and resists tearing
- Its properties remain constant in a range of temperatures and humidities
- Accepts and releases medication
- Is cost effective

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**Figure 1.** Wound after debridement on the first wound clinic visit (4 weeks after injury).

**Figure 2.** Wound 2 weeks after initial clinic visit (6 weeks after injury).
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Mepilex Ag and Mepilex Border Ag are wound care dressings where an absorbent polyurethane foam pad contains a silver sulphate compound. In the presence of fluid such as wound exudate, silver ions are rapidly released which sustainably repress a wide range of wound-related pathogens including bacteria and fungi. Each product in the Mepilex Ag range - Mepilex Ag, Mepilex Border Ag, Mepilex Border Sacrum Ag and Mepilex Heel Ag - contains the same type of silver, and Safetac technology.
Case report: Diabetic foot ulcer healing with a silver dressing combined with soft silicone technology

Six to seven weeks after initial clinic visit
By week 6 (10 weeks post-injury), the wound measured 1.5 cm x 2.5 cm and had low levels of exudate [Figure 3]. The dressing regimen remained the same. At week 7, 11 weeks after initial trauma, the wound was healed [Figure 4].

DISCUSSION
The “diabetic foot” is a group of syndromes in which neuropathy, ischaemia, and infection lead to tissue breakdown, resulting in morbidity and possible amputation [10]. A diabetic foot ulcer is a full-thickness wound below the ankle in a person with diabetes, irrespective of duration [11]. Diabetic foot ulcers may be caused by neuropathy (neuropathic ulcers) or as a result of neuropathy and ischaemia (neuropathic-arterial ulcers). Approximately 60% of all diabetic foot ulcers result from neuropathy; of these, half are related to peripheral arterial disease [12]. When people with diabetes have neuropathy, trauma and ulceration are often unnoticed by the individual until quite late, making management harder than if the person presented at the initial time of trauma. Alternatively, vascular disease or ischaemic blood flow can lead to both ulceration and, importantly, impaired wound healing. Neuropathic ulcers are found on the plantar surface of the foot, whereas ischaemic ulcers are usually found on the margins of the foot, over the toe joints, the tips of the toes, or under the toenails [13].

Clearly, diabetic foot ulcers present wound-healing challenges centering predominantly on the management of infection, exudate, and pain [15]. Offloading also has to be considered if the ulcer is caused by footwear trauma.

Management approaches need to address each factor, preferably with a dressing that can manage one or more factors to quicken the healing process and improve quality of life for the individual.

Dressings with Safetac technology employ a soft silicone that does not adhere to the wound bed, therefore preventing trauma and pain upon removal [14,15]. Such dressings also form a seal with the intact skin, inhibiting movement of exudate from the wound onto the periwound skin [14] and thus avoiding skin maceration. Numerous studies have demonstrated the effectiveness of these dressings in the care of diabetic foot ulcers [17,18]. In addition, the use of Mepilex Ag in the management of diabetic foot ulcers showing signs of infection was studied and found to be effective against methicillin-resistant Staphylococcus aureus [19].

CONCLUSION
Mepilex Ag clearly demonstrated its effect on diabetic foot ulcers with signs of infection. In addition, the dressing performance in terms of exudate management – fewer dressing changes (for more cost-effective wound management), less risk of maceration, trauma, and ease of use – was rated high by the author.

References
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Management of a diabetic foot ulcer by specialist nurses in Iran

Foot ulcers are a serious complication of diabetes that are associated with adverse consequences and high costs, as well as having a significant impact on quality of life. In this case, a man was brought to a clinic in Iran with a diabetic foot ulcer of 1 month’s duration. He had seen several physicians, and the decision had been made to amputate his leg. However, when he was seen at the authors’ clinic he was reassured that amputation could be prevented and given a treatment plan that was managed by specialist nurses. Although such specialist training is not widely available in Iran, it would positively improve wound healing outcomes.

The first author is a GP in Iran who worked at the Emam Khomeini Clinic, a charitable diabetes organisation in Tehran, as a volunteer. The organisation includes endocrinologists, surgeons, GPs, and nurses who are trained specifically in wound management and diabetes. Patient presentations are varied, and include diabetic foot ulcers and infections. However, the cooperation between the trained nursing staff and clinicians results in positive outcomes for many patients.

This case report outlines the management of an individual with a diabetic foot ulcer who presented at the Emam Khomeini Clinic, Tehran, Iran. The principles of diabetic foot management are discussed, as well as the advantages of training specialist nurses in diabetic foot care.

THE PATIENT

Mr A is a 73-year-old widower who has two adult children. He lives alone and is a retired labourer with a history of type 2 diabetes for the past 8 years. He first began to control his diabetes by means of oral treatment, but after 3 years he was advised to use insulin to control his diabetes. However, he refused therapy because of his fear of needles and injections. Mr A also had a history of hypertension and dyslipidaemia. Treatment of Mr A was irregular. Two years previously he had undergone photocoagulation for retinopathy. He was, and continued to be, a chronic smoker.

Mr A’s foot ulcer appeared approximately 1 month before he presented at the Emam Khomeini Clinic, Tehran, Iran. He initially assumed that he had a blister caused by his shoe, but as time went by it grew worse and eventually became infected. Although his son took him to see several physicians, Mr A did not agree to be admitted to hospital.

Mr A had been prescribed oral antibiotics (amoxicillin and ciprofloxacin), but did not use them regularly. He also used self-dressing and topical remedies. As a result of this, the ulcer was becoming larger and increasingly infected. It was recommended that Mr A be admitted to hospital with a diagnosis of a diabetic foot ulcer, but he would not agree to this; instead, he preferred to undergo amputation rather than undertake a period of hospitalisation. He insisted upon this method of getting rid of the ulcer, as he was exhausted by its effects, as well as facing the continual costs of treatment, dressing changes, and visits to the doctor.

Mr A was initially brought to the outpatients’ clinic to receive a diabetes card, which gives all people with diabetes in Iran access to free services, such as insulin, a blood glucose-monitoring device, and retinopathy and nephropathy screening. He was first seen by one of the clinic’s experienced trained nurses who then referred him to the consultant. She insisted that Mr A’s foot ulcer was manageable with proper home care and follow-up without the need for amputation. Initially, Mr A and his family did not accept treatment as they did not trust the nurse’s ability to manage such a problem. However, after comprehensive explanation and having been shown some examples of successful experiences with similar patients, they agreed to this course of action.
PHYSICAL EXAMINATION
Mr A’s lesion measured 4 cm x 3 cm with an ulcerated area at the base of the fourth and fifth metatarsal involving the interdigital cleft and extending to the forefront. His dorsalis pedis artery and posterior tibial artery pulses were feeble. Postural hypotension was present. Sensory impairment was revealed by the 10-g monofilament test. On close examination, the swelling showed callosity and a grade 2 ulcer, as measured by the Wagner grading system for diabetic foot ulcers. However, Mr A reported no pain from the ulcer. On probing the wound with a blunt, sterile probe, it was found to be of full thickness, extending to the underlying bone. Neurological assessment with vibration perception threshold revealed a loss of sensation in both of Mr A’s feet. Further observations are highlighted in Box 1.

Mr A did not wear appropriate shoes, and frequently wore shoes without socks. The shoes in question had a tough inner lining and a bulky section within the toe area. There was insufficient space lengthwise to accommodate his feet properly, and the sides bulged when worn.

TREATMENT AND MANAGEMENT
The management of diabetic foot ulceration is based upon the principles of wound debridement, identification and management of infection, the use of dressings to maintain a moist healing environment and offloading/redistributing pressure away from the wound. Mr A’s treatment started with ciprofloxacin 400 mg intravenously twice-daily and metronidazole 500 mg three times a day. The wound was debrided to healthy tissue and there was a moderate amount of wound exudate. An appropriate hydrocolloid dressing (Comfeel®, Coloplast) was selected as a primary dressing to absorb the exudate and provide a moist environment for healing. A secondary polyurethane foam dressing, Allevyn® (Smith & Nephew), was applied. These dressing were chosen as they are semi-permeable to water vapour, occlusive to wound exudate and absorbent. Additionally, they are available in Iran (as some medical products are sanctioned) and were acceptable to Mr A.

Home care was made by the practice nurse for redressing within 48 hours, and a weekly review appointment was made within the diabetic foot clinic. For blood pressure control, the angiotensin-converting enzyme inhibitor enalapril 5 mg/day was commenced. Mr A also improved his insulin regimen and began to achieve optimum blood glucose levels. It is important to maintain the principles of optimum wound management; at each visit, Mr A’s wound was assessed by the trained nurse for signs of infection, as infection in the diabetic foot can spread rapidly.

During the first week, the diameter of the wound remained the same, but the exudate had decreased considerably. Mr A’s blood glucose was under control and slight physical activity was initiated by the nurses. Two weeks after initiation of treatment, the diameter of the wound was 2.5 cm x 3 cm. Systemic antibiotics were discontinued and oral antibiotics were started (amoxicillin 500 mg every 8 hours and ciprofloxacin 500 mg every 12 hours). The dressing had been changed twice a week by the nurse. During this time, Mr A and his family had been taught how to change the dressing, how to interpret glucose meter readings, and how to administer appropriate insulin dosages.

By week 4, the diameter of the wound was 1.0 cm x 1.5 cm. Mr A was completely satisfied with the care he had received and the treatment process.

By week 6, the wound had reduced to 0.5 cm x 0.5 cm, the oral antibiotics were stopped and Mr A had learned how he could take care of his foot, how to clean his foot and nails, and how to choose suitable shoes. He was also aware of appropriate physical activity, and he and his family had learned how they could screen Mr A’s foot. He agreed to come to the clinic for follow-up appointments and screenings at least every 3 months. Mr A’s ulcer was fully healed by week 12.

SPECIALIST NURSE TRAINING
At the Emam Khomeini Clinic, all nurses are trained in educating people with diabetes, particularly those at risk of foot ulcers. This enables them to become familiar with the basics of foot care, teaches them how to perform physical examinations and to take care of their feet on a daily basis, and encourages them to carry out a series of simple tasks in order to help prevent foot ulcers or recurrence. Tasks include checking shoes before wearing them, keeping feet clean, continued care of the skin and nails, maintaining good blood glucose control, regularly changing the dressing, and moisturising and cleaning the wound.

DISCUSSION
Trauma to the foot in people with diabetes is one of the most important factors in the development of an ulcer, particularly in the presence of sensory

### Box 1. Observations made on presentation of Mr A to the clinic

- Plain radiography: osteomyelitis, osteolysis soft-tissue gas, medial arterial calcification
- Technetium-99m methylene diphosphonate bone scan: osteomyelitis, neuropathic arthropathy
- Calluses: discoulouration, sub-callus, haemorrhage
- Fissures and nail appearance: onychomycosis, dystrophic calcification, paronychia, signs of atrophy
- Pulse rate: 96 bpm
- Blood pressure: 154/98 mmHg
- Fasting blood glucose: 205 mg/dL
- HbA1c: 7.5 mmol/mol (9.0%)
neuropathy. Although this trauma could be a puncture wound or a blunt injury, the most common one is repetitive stress trauma\(^6\), such as that caused by Mr A's unsuitable footwear.

Foot ulcers are a serious complication of diabetes that are associated with adverse consequences and high costs, as well as having a significant impact on individuals' quality of life\(^7\). Care of this group demands a multidisciplinary approach\(^8\). A specialised, interdisciplinary team should work closely with patients and their families to effectively manage and treat diabetic foot ulcers\(^9\), as evidenced in Mr A's case. However, this level of care is not yet accessible to all people with diabetes in Iran, and few patients with foot ulcers receive effective wound management\(^10\).

In a study in Mazandaran, Iran, of 520 people with diabetic foot problems\(^11\), it was clear that inappropriate quality of ulcer and foot care occurred in 54% and 66% of participants respectively, and most people were treated surgically (28% debridement and 57% amputation). The authors concluded that the main reason for this inappropriate service was the lack of nurses trained in wound management in the country.

Although some people with diabetes, particularly those with foot ulceration, believe that their condition should be treated by physicians (as Mr A and his family believed at first), the role of non-physician healthcare providers has been accepted by patients in many countries\(^12\). Nurses are well placed to provide high-quality care and to undertake a leading role in wound management, specifically in the care of people with diabetes\(^13\). Furthermore, nurses can facilitate and positively influence wound healing outcomes by promoting, collaborating, and participating in interdisciplinary care teams\(^14\). However, the role of nurses in Iran and other developing countries is unclear, and there is a lack of a defined philosophy for nursing in Iran. In a study conducted by Adib Hajbaghery et al (2008) a systematic review of the effectiveness of interventions to enhance the healing of chronic ulcers of the foot in diabetes. Diabetes Metab Res Rev 24 (Suppl 1): 19–44

In a study in Babol, North of Iran: an evidence-based multidisciplinary approach in the management of diabetic foot ulceration in Babol, North of Iran. Iran J Nurs Midwifery Res 15(4): 150–4


CONCLUSION

Patient education, comprehensive foot screening, correct dressing choice, effective debridement, and routine follow-up, are the most effective strategies in preventing and managing diabetic foot ulcers. Specialist nurses are well placed to provide effective foot ulcer management and treatment; however, nurses in some developing countries, such as Iran, highlight a lack of specialist training as an obstacle to effective healthcare provision.

Fortunately, in Mr A’s case, his foot was saved from amputation as a result of the optimal home wound care and follow-up treatment he received from the healthcare team, particularly the trained nurses. Moreover, Mr A’s quality of life improved, enabling him to interact and integrate socially within his environment, to participate in diabetes group activities and classes after becoming mobile and to enjoy his improved wellbeing.

However, from this case and many similar cases in Iran and other developing countries, it is clear that there is a lack of services that are mainly provided by specialist nurses. In Mr A’s case, despite benefitting from this service, his infected ulcer would not have initially occurred had his feet been screened regularly, had he been taught about personal foot care earlier, and if he and his family had trusted the nurse’s abilities.

A multidisciplinary team approach is needed to deal with the complexity of the diabetic foot ulcer, and nurses should be provided with skills for effective management. The main components of a diabetic foot service, such as education, screening, wound management and follow-up for preventing recurrence, may be provided by trained nurses, as is happening in many countries such as the UK. Currently, nurses have shown a strong commitment to change and improve the healthcare services and systems in Iran. Nursing in Iran has seen great progress in recent years. Restructuring nursing services in Iran would eliminate barriers to poor-quality nursing care, inadequate educational preparation, role ambiguity and low self-esteem among nurses.
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Hypertension (diagnosed in 1999), and peripheral neuropathy (diagnosed in 2000). Ms Z’s presenting HbA1c was 74 mmol/mol (8.9%); however, medical records revealed a long history of suboptimal glycaemic control. Medication included atenolol 25 mg once-daily, simvastatin 40 mg once-daily and metformin 850 mg twice-daily. Ms Z was also a known smoker of 20 years.

CLINICAL PRESENTATION
Ms Z presented with a plantar calcaneal ulcer, which was graded as Texas classification 3B (bone or joint involvement/non-ischaemic infected), measuring 50 mm x 65 mm [Figure 1]. The exudate levels were high, causing surrounding periwound maceration. The wound base was granulating; however,

MANAGING A COMPLEX, HIGHLY EXUDING WOUND PRESENTS A CHALLENGE TO EVEN THE MOST EXPERIENCED CLINICIANS. ADVANCES IN WOUND CARE PRODUCTS NOW ENABLE THE CLINICIAN TO TAILOR WOUND CARE REGIMENS BASED NOT ONLY ON THE PRESENTING WOUND AETIOLOGY, BUT ALSO ON THE PHYSICAL AND FINANCIAL CONSTRAINTS OF MANY HEALTHCARE PROVIDERS. THE IMPORTANCE OF THE LATTER HAS NEVER BEEN MORE EVIDENT AS THE DEMAND FOR HEALTH SERVICES ARE AT A PEAK. THEREFORE, IF CLINICIANS CAN REDUCE THE NUMBER OF DRESSING CHANGES AND THEREBY REDUCE PATIENT CONTACT, IMPROVING CLINICAL EFFICIENCY WHILE MAINTAINING THE EFFICACY OF WOUND CARE TREATMENTS, SUCH WOUND DRESSINGS WOULD BE HIGHLY ATTRACTIVE TO THE HEALTHCARE PROVIDER.

CASE REPORT OUTLINES THE MANAGEMENT OF AN INDIVIDUAL WITH DIABETIC FOOT ULCERATION WHO PRESENTED TO LIVERPOOL HOSPITAL, SYDNEY, AUSTRALIA.

THE PATIENT
Ms Z, a 65-year-old woman with longstanding type 2 diabetes, was referred to the high-risk foot service with a right foot, plantar calcaneal neuropathic ulceration. The ulceration originated as a result of increased plantar pressure caused by a Charcot neuropathic osteoarthropathy foot deformity. She was an inpatient in the hospital under the care of the vascular surgery team for a non-related foot pathology. Ms Z’s medical history included type 2 diabetes (diagnosed in 1995), hypertension (diagnosed in 1999), and peripheral neuropathy (diagnosed in 2000). Ms Z’s presenting HbA1c was 74 mmol/mol (8.9%); however, medical records revealed a long history of suboptimal glycaemic control. Medication included atenolol 25 mg once-daily, simvastatin 40 mg once-daily and metformin 850 mg twice-daily. Ms Z was also a known smoker of 20 years.

Managing a complex, highly exuding wound presents a challenge to even the most experienced clinicians. Advances in wound care products now enable the clinician to tailor wound care regimens based not only on the presenting wound aetiology, but also on the physical and financial constraints of many healthcare providers. The importance of the latter has never been more evident as the demand for health services are at a peak. Therefore, if clinicians can reduce the number of dressing changes and thus reduce patient contact, improving clinical efficiency while maintaining the efficacy of woundcare treatments, such wound dressings would be highly attractive to the healthcare provider.

This case report outlines the management of an individual with diabetic foot ulceration who presented to Liverpool Hospital, Sydney, Australia.

A NEW DOUBLE-LAYERED HYDROFIBER® DRESSING FOR MANAGING THE HIGHLY EXUDING WOUND

A complex, highly exuding wound presents a challenge to even the most experienced clinician. For an effective management approach, the clinician must be able to select the correct dressing based on the characteristics of the patient’s wound and needs, as well as considering cost. In this case report, a new double-layered Hydrofiber® (ConvaTec) dressing, with stitch bonding that increases tensile strength, was used in combination with an absorbent foam as the secondary dressing. This improved the patient’s quality of life, as well as reducing the financial burden of managing a complex, chronic wound.

A new double-layered Hydrofiber® dressing for managing the highly exuding wound

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the calcaneus was clearly exposed at the inferior aspect of the wound. The ward nurses had been dressing the wound every day with a multilayered dressing pad because of the levels of exudate and strike-through; however, on initial presentation, the dressing was oversaturated.

**ASSESSMENT**

A Modified Neuropathy Disability Score (MNDS) was undertaken, which indicated dense diabetic peripheral neuropathy with a patient score of 10/10. The MNDS is a composite measurement indicating that the maximum deficit score of 10 would indicate complete loss of sensation, while a MNDS of ≥6 equates to an increased risk of insensate foot ulceration. The tibialis posterior and dorsalis pedis pulses were palpable, indicating good peripheral blood flow.

**INVESTIGATIONS**

A plain X-ray showed chronic calcaneal osteomyelitis with erosion of the inferior aspect on the plantar calcaneum. Inflammatory markers showed only mildly elevated signs: white blood cell count was 8.0 $\times$ 10^9/L, electron spin resonance was 35 mmol/L and C-reactive protein was 7.2 mg/L. Bone sequestra was obtained from the base of the wound and sent for semi-quantitative microbiology, culture, and sensitivity. The results of the swabs indicated a 2+ *Pseudomonas aeruginosa* as a coloniser and 3+ *Staphylococcus aureus* as a possible pathogen of infection.

**TREATMENT AND MANAGEMENT**

In consultation with the vascular surgery team, Ms Z's chronic osteomyelitis was treated conservatively; she was prescribed amoxycillin 875 mg plus clavulanic acid 125 mg (Augmentin® Duo Forte) in combination with ciprofloxacin 500 mg every 12 hours. She was immediately discharged following the high-risk foot clinic consultation, and follow-up was weekly with the high-risk foot team and the community nursing team.

With regards to the dressing protocol, the clinicians were not only focused on controlling the level of exudate to limit peri-wound maceration, but also on the interval time between dressing changes. Ms Z had expressed her concerns regarding the amount of dressing changes required as an inpatient (daily dressings), and that if this were to continue it would impact on her normal daily life. In addition, the community nursing team expressed their desires to avoid daily dressings if possible because of the increasing demands on their service.

For this reason, a new dressing technology comprising a double-layered, stitch-bonded Hydrofiber (Aquacel Extra®, ConvaTec) was used as the primary dressing in combination with a secondary dressing of an absorbent foam to:

- Control the level of exudate and thus peri-wound maceration.
- Extend the time between dressing changes without impacting on the above.
- Maintain an optimal wound environment, while systemic antibiotics addressed the infection process.

The dressing plan was implemented and on the advice of the high-risk foot team the community nurses changed the dressings once weekly. During this period, no strike-through or saturation of the dressings were reported. At day 14 after initial presentation, the wound exhibited improved granulation and there was no peri-wound maceration even though the exudate levels were moderate to high. The dressing regimen continued with twice-weekly changes, and Ms Z was reviewed by the high-risk foot team 34 days after presentation. At this point, there was marked granulation and the ulcer had reduced in size to 40 mmx40 mm. There was minimal to no peri-wound maceration, and importantly the dressings used were not oversaturated with exudate. The level of exudate had also reduced to a mild-to-moderate level as a probable result of the systemic antibiotic therapy.
DISCUSSION
Managing the complexity of a chronic, highly exuding wound presents a challenge to even the most experienced clinician. In order to develop an effective management approach, the clinician must be able to select the correct dressing regimen based on the characteristics of the wound and also the patient’s needs. Today’s health care is economically driven, and this is an important consideration when managing a pathology such as a wound or ulceration that poses a large financial burden. Although no up-to-date costs are readily available within Australia, a UK-based study estimated the annual expenditure for the care of chronic wounds to be £2.3–£3.1 billion at 2005–6 prices[1].

The focus of managing the patient in this case report was not primarily the calcaneal osteomyelitis, but more how to efficiently utilise a dressing regimen that would cater for the multiple needs of the patient, clinician and healthcare resources. Even though the underlying infective process was the cause of Ms Z’s increased exudate, the wound required a dressing that could optimise the action of antibiotics by creating an optimal wound environment, while managing the high exudate levels and reducing periwound maceration and strike-through of the dressing.

A new double-layered Hydrofiber technology (Aquacel Extra®) incorporating a stitch bonding that increases tensile strength was used in combination with an absorbent foam as the secondary dressing. At no point over the course of using this new regimen were the dressings reported to have strike-through, and as such this dressing regimen enabled the time between community nursing visits to be extended from daily, which was occurring in the hospital, to once weekly at the patient’s home and once weekly at the high-risk foot clinic. The foreseen economic advantages of using absorbent dressings and “modern dressing” regimens to reduce patient visits, reduce dressing changes and therefore reduce dressing costs have been well documented[4,5]. In one such study on absorbent dressings for pressure ulcers, the study compared them against traditional dressings. A reduction in the financial burden of 56% was noted, largely as a result of the lower frequency of dressing changes, reduction in the cost of nursing time and a reduction in the average cost per week of materials[6]. Importantly for Ms Z, she commented that she had an improved quality of life, which was attributed to no unpleasant strike-through on the dressings, reduced malodour and the reduction in community nursing visits that allowed for a more normal lifestyle instead of planning her days around the community nursing visits.

CONCLUSION
There is a fine line between balancing the needs of the patient against the financial and infrastructure burdens of the healthcare system. As the demand for healthcare services increases, the utilisation of resources is paramount. This case report identifies the possible advantages of a new Hydrofiber dressing, which may enable an improved quality of life for the patient, as well as reducing the financial burden of managing complex chronic wounds, such as diabetic foot ulceration.

References
SELECTED PAPERS OF INTEREST

1. Combination treatment for foot osteomyelitis.
2. Primary surgical closure of osteomyelitis improves healing.
3. Monitoring device assesses prescribed footwear adherence.
4. Patient adherence to prescription footwear is low.
5. Non-removable casts associated with increasing healing.

1 Combination treatment for foot osteomyelitis

- People with dense peripheral neuropathy and/or peripheral vascular disease are at an increased risk of lower extremity amputation as a result of diabetic foot infections. Concomitant osteomyelitis is difficult to treat in people with diabetes.
- The authors undertook a prospective cohort study in people with diabetes and foot (mainly forefoot) osteomyelitis (n=330; study group) and those with a foot ulcer but without osteomyelitis (n=1808; control group). Foot osteomyelitis was diagnosed by the probe-to-bone test, microbiological studies of bone cultures or repeated plain radiographic findings.
- Surgical treatment of osteomyelitis included debridement, sequestrectomy, resections of metatarsal and digital bones or toe amputation. Medical treatment comprised 6 weeks of antibiotic therapy. Participants were followed for a minimum of 12 months after wound healing.
- The authors found that in people with diabetic foot osteomyelitis, the best treatment results were achieved using a combination of surgical sequestrectomy and prolonged oral antibiotic therapy.
- The authors concluded that acceptable diabetic limb salvage rates could be achieved by combined medical and surgical care. They also found that this combined treatment lowered the healing time, the duration of treatment with antibiotics and the wound recurrence rate.


2 Primary surgical closure of osteomyelitis improves healing

- In this comparative study, the authors assessed the incidence of post-surgical complications following primary surgical closure of diabetic foot osteomyelitis. They compared this with healing by secondary intention in 46 people with diabetic foot ulceration and clinical signs of osteomyelitis.
- Primary surgical closure was carried out on 73.9% (n=34; group 1) of the study cohort, while the remaining 26.1% (n=12; group 2) healed by secondary intention.
- Primary surgical closure was not associated with a significantly higher rate of complications than secondary intention (61.9% [group 1] versus 61.3% [group 2]; P=0.843). Participants who had undergone primary surgical closure had significantly faster healing rates (P=0.008) and less exudation, oedema, and reinfection.


3 Monitoring device assesses prescribed footwear adherence

- Diabetic foot ulcers require early diagnosis and aggressive management to limit the risk of amputation. The aim of this observational study was to evaluate the validity and feasibility of an in-shoe temperature-based adherence monitor in measuring footwear use.
- The study group was made up of healthy people (n=11) and participants with neuropathic diabetes who were at a heightened risk of developing foot ulceration (n=14).
- The validity of the in-shoe adherence monitor for healthy participants was assessed by comparing its registrations of putting on and taking off footwear over a 7-day period. A usability questionnaire was also completed.
- Participants with diabetes tested the feasibility of using the monitor over 7 days, and a time-synchronised step-activity monitor was also worn on the ankle to register the use of prescribed footwear when walking.
- The authors concluded that the adherence monitor showed good validity in measuring if footwear was being used. They found it to be a feasible and objective way of assessing treatment adherence alongside instrumented monitoring of walking activity.

Wound digest

This digest summarises some of the key papers published on the management of diabetic foot ulcers.

4 Patient adherence to prescription footwear is low

Ulcer recurrence in people with diabetes can be significantly reduced when patients wear custom-made footwear consistently. However, yearly recurrence rates are high and objective data examining adherence to prescription footwear are lacking.

The authors aimed to objectively measure adherence in 107 people with diabetes using a temperature-based monitor placed inside prescription footwear. Daily step count was measured by an ankle-worn activity monitor.

Adherence to wearing custom-made footwear was quantified by the percentage of steps taken in prescription footwear. Mean ± standard deviation adherence was 71 ± 25%. Adherence was found to be lower at home (61 ± 32%, over 3959 ± 2594 steps) compared to outside the house (87 ± 26%, over 2604 ± 2507 steps).

Multivariate regression analysis revealed that lower BMI (P=0.066), greater foot deformity (P=0.034), and more aesthetically pleasing footwear (P=0.032) were significantly correlated with improved adherence. A total of 35 participants displayed low adherence (<60%). In this group, adherence at home was 28 ± 24%.

The authors concluded that adherence to wearing prescription footwear is low, especially in the home environment. These findings can be used in the development of schemes to improve adherence and reduce ulcer recurrence in people with diabetes.


5 Nonremovable casts associated with increased healing

Diabetic foot ulcers often occur as a result of abnormal pressures on the sole of the foot. Plantar pressure relief is a common treatment for diabetic foot ulcers, but the most effective method for healing remains unknown.

The authors aimed to assess the effects of different pressure-relieving treatments on the healing of diabetic foot ulcers.

Electronic searches of the Cochrane Wounds Group Specialised Register, the Cochrane Central Register of Controlled Trials, the Cochrane Library, Ovid MEDLINE, Ovid EMBASE, EBSCO, and CINAHL were conducted. A total of 14 randomised controlled trials with 709 participants were included.

Nonremovable casts were associated with an increased number of healed ulcers compared with removable devices (risk ratio [RR], 1.17; 95% confidence interval [CI], 1.01–1.36; P=0.04).

A higher proportion of ulcers healed with the use of nonremovable casts compared with dressings. When used together, Achilles tendon lengthening paired with a nonremovable cast healed significantly more ulcers at 7 months (RR, 2.23; 95% CI, 1.32–3.76) and 2 years (RR, 3.41; 95% CI, 1.42–8.18) compared with the sole use of a non-removable cast.

Nonremovable interventions were found to be more effective in ulcer healing than other external pressure-relieving devices. Nonremovable casts and Achillies tendon lengthening were more successful when used together than a solitary nonremovable cast.


6 New IDSA guidelines for treating diabetic foot infections

The Infectious Diseases Society of America (IDSA) have published new guidelines for treating diabetic foot infections. The authors propose a classification system to be used alongside vascular assessment in determining which patients require hospitalisation, special imaging, or surgical intervention.

Healthcare professionals should classify infection and then stratify by severity. Tissue culture results, clinical and epidemiological data should inform antibiotic regimen and definitive therapy.

The IDSA highlights the necessity of multidisciplinary foot care teams in improving patient outcomes.
