An open, non-comparative, multi-centre evaluation of performance and safety using an antimicrobial exudate transfer dressing on diabetic foot ulcers: a case series

• **Objective:** To evaluate the performance and safety of Mepilex Transfer Ag (MTAg) in the treatment of infected diabetic foot ulcers (DFU).

• **Method:** Patients with locally infected DFU were treated with the test dressing for up to 4 weeks, with a further 12 weeks of follow-up in a non-comparative study. Changes to wound infection and wound size as well as the condition of the peri-wound skin from baseline were assessed. Wound pain during dressing change was measured using a visual analogue scale (VAS). The investigators and patients documented their opinions on their overall experience of the test dressing and on key performance parameters.

• **Results:** Following treatment with the test dressing, the signs and symptoms of local wound infection present in the target DFU were substantially reduced compared with baseline. Following the post-treatment evaluation, the majority of the DFU exhibited no signs of infection. and mean wound size was reduced by 50%. Wound size also continued to steadily decrease during follow-up. At the end of treatment five DFUs were completely healed and a further six healed by the end of the follow-up period. Concomitantly, over the course of the study, wound exudate levels were reduced and there was a significant improvement in the condition of the peri-wound area. Wound pain at dressing change was low throughout; generally patients felt no anxiety during the dressing change procedure. The patients considered it a comfortable dressing that remained in place and allowed ease of movement during wear. The investigating clinicians were highly satisfied with the overall performance, especially with respect to its ease of application and removal, conformability and flexibility.

• **Conclusion:** This study has demonstrated the potential of the dressing to provide topical antimicrobial activity directly to an infected DFU, suggesting prompt treatment of an infected DFU with this topical antimicrobial could aid wound complications.

• **Declaration of interest:** The authors have no conflict of interest to declare.

anti-bacterial agents; diabetic foot; silver; wound healing; wound infection

K. Dhatariya,[1] Consultant Diabetologist;
C. Gooday,[1] Principal Podiatrist1
B. Franke,[2] Department of Diabetes/ Endocrinology;
T. Pilling,[2] Advanced Podiatrist;
A. Flanagan,[2] Podiatrist;
L. Zeidan,[2] Research Sister;
1 Elsie Bertram Diabetes Centre,
Norfolk and Norwich University Hospitals NHS Foundation Trust,
Colney Lane,
Norwich
United Kingdom

Continued page 258

One of the most significant and distressing complications of diabetes is the development of a diabetic foot ulcer (DFU). A DFU can have a negative impact on a patient's physical and psychological well-being, can severely reduce their quality of life and places a financial burden on families and society. A combination of risk factors are associated with the development of a DFU, neuropathy, ischaemia and pressure. As a consequence of these underlying aetiologies, DFU are associated with a lower probability for wound healing and there is a greater risk of non-traumatic amputation. An added risk is infection. Infected wounds can deteriorate rapidly, increasing the threat of amputation. People with diabetes are at much greater risk of amputation—more than 25%—than someone without the condition[1] with over 85% of diabetes-related lower extremity amputations being preceded by a DFU.[2] Therefore, good management of a DFU is imperative.

The effective management of a DFU requires the underlying disease processes to be treated. This requires infection to be treated, an adequate blood supply to be provided and the wound to be offloaded to relive pressure.[3]

The local wound care of a DFU requires repeated debridement, frequent inspection, and controlled moisture balance to help prevent maceration. Dressings must therefore be selected that alleviate symptoms, afford wound protection and support healing.[4] They must successfully manage wound exudate but maintain a moist wound environment for optimal wound healing. In addition, dressings should be atraumatic to the wound and surrounding skin on removal and minimise pain during dressing procedures.[5] However, because of the high amputation risk

Table 1. Participant inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Individuals ≥18 years old	Dry wound
Type 1 or type 2 diabetes mellitus	Known allergy/hypersensitivity to the dressing
Minimum of two of the signs of infection present and recorded (redness, heat, oedema, pain, increased level of exudate, deteriorating wound, fever, odour)	Treatment of the target ulcer with another silver dressing within the previous seven days
Ulcer localisation below the ankle	Subjects who will have problems following the clinical investigation plan
Signed informed consent	Subjects included in other ongoing clinical investigation at present or within the previous 30 days. Subjects participating in a clinical sample investigation* could be enrolled

*A clinical sample investigation involves one or several samples from the subject at baseline. No treatment is involved and no follow-up.

2 The Rotherham NHS Foundation Trust, Rotherham

Email: ketan.dhatariya@nnuh.nhs.uk

for patients with diabetes with an infected DFU, the timely control of wound infection is vital.[3] The Eurodiale study recruited over 1,000 patients with diabetes related foot disease from 14 centres across Europe and found that 58% of the patients attending a foot clinic with a new ulcer had a clinically infected wound.[6] Therefore, early treatment for even mildly infected DFUs is essential, and can include the use of systemic and topical antimicrobials. Antimicrobial dressings have the potential to reduce the bacterial load and may protect the wound from further contamination.

Mepilex Transfer Ag (MTAg), with Safetac technology, is a soft silicone wound contact layer with antimicrobial properties. This dressing has been previously demonstrated to provide an effective bacterial barrier against a broad spectrum of microorganisms.[7] The dressing has also been shown to maintain a moist wound healing environment while minimising the risk of wound maceration.[8] Wound exudate has been shown to be transferred vertically through the wound contact layer into an absorbent secondary dressing,[8] and the Safetac adhesive technology prevents lateral movement of exudate onto the healthy intact wound margin.[9] In addition, previous work has shown that the dressing is atraumatic so minimising wound trauma and dressing-related wound pain.[10]

Objectives

The primary objective of this investigation was to evaluate the performance and safety of MTAg in the treatment of infected DFU. This was measured as a change in the signs and symptoms of local wound infection. Secondary objectives assessed wound size reduction/ time to wound healing, the ability of the dressing to manage wound exudate, condition of the peri-wound skin, dressing-related wound pain, and any adverse events or adverse device events. The investigators and patients evaluated the dressing.

Methods

Patients with an infected DFU were enrolled into the open, non-comparative study. Infection was diagnosed clinically, as recommended by the Infectious Disease Society of America.[11] Briefly, infection was diagnosed if there were at least two classic symptoms or signs of inflammation (erythema, warmth, tenderness, pain, or induration) or purulent secretions present. The severity of the infection was classified according to its extent and depth and the presence of any systemic findings of infection. The study was performed at two different investigation sites in the UK, and both in- and out- patients that met the inclusion/ exclusion criteria were eligible (Table 1). Before enrolment began, the study plan, the patient information sheet and consent forms were approved by an independent ethics committee review board.

Intervention

Patients were treated with the dressing according to the usual standard of care provided at the study sites for a maximum of four weeks, unless antimicrobial action was no longer required. Standard care was provided in line with NICE guidelines[12] which was updated in 2015 and included, wound debridement, off-loading, the assessment and management of infection, peripheral arterial disease, and diabetes. Secondary dressings were applied as appropriate. Study participants attended an initial baseline assessment and four scheduled evaluation assessments at weekly intervals, after which additional treatment was provided at the discretion of the study clinicians and wounds were monitored for up 12 weeks with assessment visits scheduled at 4, 8 and 12 weeks after the treatment finished.

Dressing changes were performed according to local clinical practice. Dressings were always changed at each scheduled visit. If dressings needed to be changed in between the scheduled visits, these were done at the discretion of the patient/ clinician.

Data collection

The patient demographics and medical history were documented at the baseline assessment, and the history of the DFU established, the wound's location and classification, the ankle-brachial pressure index (ABPI) value, the presence/absence of ischemia and the most recent glycated haemoglobin (HbA1c) value (within 3 months) were recorded.

At the baseline and each of the scheduled visits, the following were assessed:

- Signs/symptoms of wound infection (redness, heat, oedema, changes in the consistency and quantity of exudate, wound pain, fever)
- The condition of the wound and the surrounding

skin, in particular the presence of any maceration, redness, blistering, eczema or wound odour
- The size of the wound—determined using the PictZar digital planimetry program (BioVisual Technologies, Elmwood Park, NJ)
- The need for debridement
- The level of wound pain, before dressing change, during dressing change and after dressing reapplication—using a visual analogue scale (VAS) ranging from 0 (no pain) to 100 (worst pain ever)
- Any adverse events/ adverse device events (AE/ADE), and if so, were they dressing related
- Key dressing performance parameters and the overall experience of using the study dressing—questionnaires completed by investigators and patients at each scheduled visit (Table 2)

Table 2. The key dressing performance variables evaluated by the investigators and patients

Patient evaluation	Investigator evaluation
Anxiety experienced at dressing change	Ease of application and removal
Ease of movement while wearing	Flexibility
Ability of product to remain in place	Lack of adherence to wound bed
Stinging or burning experience	Adherence to healthy intact skin
Comfort during wear	Ability to absorb exudate
	Conformability
	Exudate transfers through dressing
	Ability to change only the secondary dressing
	Overall experience

Pain assessment

At the baseline assessment and each scheduled visit, patients were asked to rate their pain levels (pain before the initial application of test product; before the removal of the secondary dressing; before removal of the test product; during the removal of the test product; after removal of the test product; 30 minutes after removal of the test product) using a 100mm VAS. VAS scores were recorded for all 24 eligible patients at the baseline and initial scheduled visit, thereafter VAS scores were only recorded for patients that continued to receive MTAg treatment.

Statistical analysis

Descriptive statistics (mean and standard deviation; median and range) were applied to the primary and secondary objectives when quantitative data were established.

Results

Initially 26 patients were recruited however, two of the patients were withdrawn after the baseline assessment and accordingly are not included in the intention to treat (ITT) population evaluations since they did not provide any information post-baseline.

A total of 24 diabetic patients (87.5% male) with a DFU that received post-enrolment treatment with MTAg at the Norfolk and Norwich University Hospital, UK (n=14) or the Rotherham Hospital, UK (n=10) between March 2014 and April 2015 were included in the ITT analysis. There were three patients who terminated the investigation period early (2 patients were transferred to different hospitals and one patient was withdrawn following diagnosis of a malignant melanoma), therefore 21 patients were included in the ITT post-study analysis.

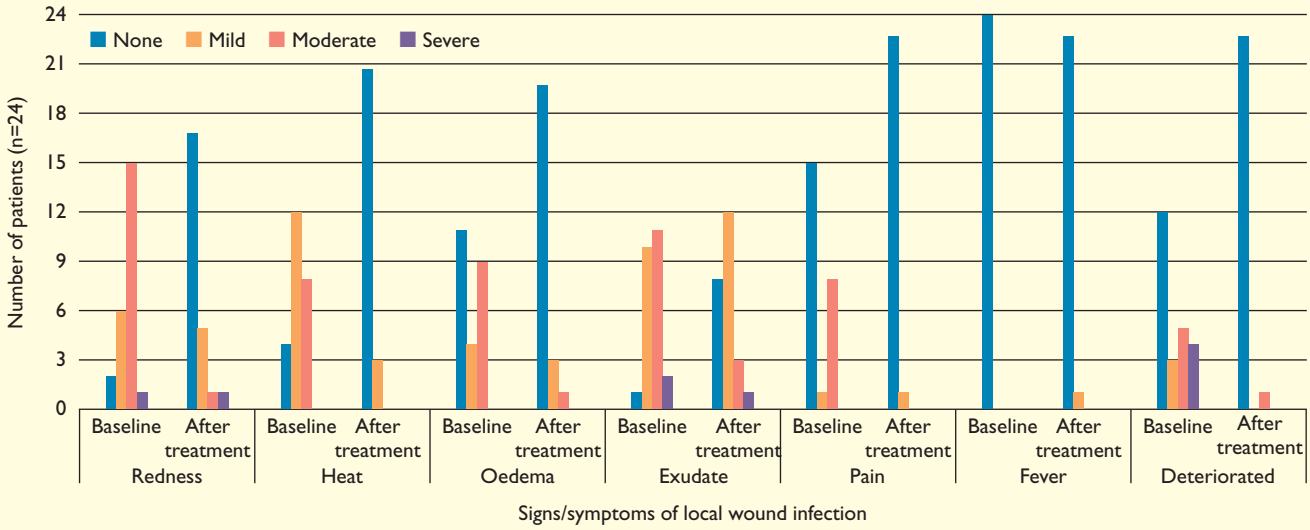
The median age of the patients was 61.5 years (range: 38–82 years) with two patients chair-bound. There were four patients who had type 1 diabetes and of the 20 patients with type 2 diabetes, 13 (65%) required insulin treatment. The median duration of diabetes among the patient population was 14 years, (range: 1—40 years). The median HbA1c was 67.5 mmol/mol, (range; 40—125 mmol/mol). Peripheral neuropathy was present in 11 patients (45.8%) and 15 patients had undergone relevant surgery.

The median duration of the DFUs was 4 weeks (range: 1—208 weeks); 6 ulcers were ischaemic (25%). The most common location was the plantar surface (Table 3). Before the intervention, 19 of the ulcers had been treated with other wound dressings, and four also received additional treatment, such as antibiotics. During the treatment period with MTAg, 20 patients

Table 3. Location and classification of the diabetic foot ulcers

Location of target ulcer	Number of patients (%)
Left/right foot	15 (62.5)/9 (37.5)
Plantar surface	10 (41.7)
Heel plantar	1 (4.2)
Heel	3 (12.5)
Hallux	2 (8.3)
Hallux plantar	3 (12.5)
Digitalis II–V	4 (16.7)
Other	1 (4.2)
Texas wound classification—stage	
A	1 (4.2)
B	17 (70.8)
C	1 (4.2)
D	5 (20.8)
Texas wound classification—grade	
1	12 (50)
2	6 (25)
3	6 (25)

Fig 1. A comparison of the signs and symptoms of local wound infection at the baseline assessment and at the end of treatment



were prescribed antibiotic therapy; 12 of these were as a result of another infection and 12 patients received antibiotic treatment through the follow-up.

All of the DFUs received standard specialist podiatric care, including sharp debridement during the dressing change procedure. Debridement was performed at the discretion of the investigator as was the choice of secondary dressing. The patients were prescribed off-loading whenever deemed appropriate by the study teams during the study.

Changes in the signs and symptoms of local wound infection

At baseline, over 95% of the DFUs had between three and five of the signs and symptoms of infection with 63.4% of these regarded as moderate to severe; 22 of the DFUs (91.7%) showed signs of redness, 20 (83.3%) were warm and 13 (54.2%) had oedema, nine (37.5%) reported wound pain and 12 (50.0%) wounds had deteriorated since the last assessment before entry into the study. Wound exudate was present in 23/24 DFUs (95.8%, Fig 1).

At the point MTAg treatment was either no longer deemed necessary or after a maximum of 4 weeks, the signs and symptoms of local wound infection were observed to have improved in 23/24 DFUs (95.8%). Local wound infection was absent in 4 DFUs (16.7%) and 13 (54.2%) had only one sign/symptom of infection remaining, generally mild exudation, redness or oedema. A further four ulcers (16.7%) still exhibited two signs/symptoms of local wound infection, but only at levels considered 'mild' by the investigators. However, two DFUs showed only minor improvements to local wound infection (8.3%) and one wound had deteriorated (Fig 1).

At the end of the post-study evaluation period of the 21 patients remaining in the study, 16 DFUs (76.2%) were infection-free. Local wound infection remained stable in one (4.8%), and deteriorated slightly in 4 (19%).

Wound status

At baseline, the mean total wound area (±SD) of the DFUs was 3.06cm^2 (7.92). At the point MTAg treatment was stopped the mean (±SD) total wound area had reduced by 44% to 1.72cm^2 (4.69), five DFUs (20.8%) healed during the treatment period. During the subsequent 12 week follow-up period (21 patients) an additional six ulcers healed and the wound area of a further six DFUs continued to decrease. In 4 cases (19%) the size of the DFU increased.

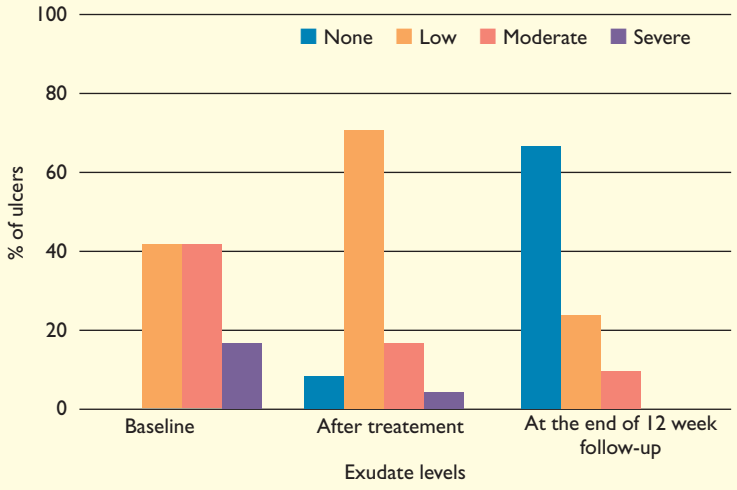
The condition of the peri-wound skin surrounding 18 DFUs (75%) was not healthy at the baseline investigation with signs of mild or moderate maceration, redness, blistering and/or wound odour. Following treatment with MTAg the surrounding skin of 17 (71%) of the DFUs was healthy and intact, the condition of the peri-wound skin had improved in an additional three ulcers and remained in the same condition in three. The peri-wound skin deteriorated in one person. At the end of the 12 week follow-up period, 18/21 DFUs (85.7%) had healthy intact peri-wound skin and the condition of surrounding skin had improved in two of the ulcers (9.5%). Deterioration of the peri-wound skin was only seen in one DFU.

All of the wounds were exuding at baseline, eight (33.5%) had serous wound exudate, with the remainder (66.5%) having exudate that was sanguinous, serosanguinous or purulent. There were 11 DFUs (79%) with moderate/copious levels of exudate. After treatment with MTAg, the level of wound exudation improved in 15 DFU (62.5%) and it remained con-

stant in 7 (29.2%). Exudation deteriorated in two (8.3%). The nature of the wound exudate had significantly improved, being completely absent in two DFUs (8.3%) and in 16 (66.7%) wound exudate was serous in its nature. Wound exudate that was sanguinous, serosanguinous or purulent in the remaining 6 DFU (25%).

At the end of the post-study evaluation period, 14/21 ulcers (66.7%) were not exuding, with wound exudation improving in 1/21 DFU (4.8%) and levels of wound exudate remaining constant in six (23.1%) (Fig 2).

Fig 2. Wound exudation levels in the diabetic foot ulcers



Pain assessment at dressing change

The mean pain score at the baseline assessment, before initial application of the test product, was 15.8 (SD: 24.4). During treatment period, the VAS pain scores reported at all of the dressing change assessment points were reduced from baseline; the overall mean pain score was 4.6 (SD: 1.36).

Investigator evaluation of the dressing

At each of the scheduled visits, the investigators, on average, rated their overall satisfaction of MTAg as a transfer layer dressing as 'very good'. Assessment of key dressing performance parameters at each of the scheduled visits also showed that, on average, the test dressing was rated 'very good' in terms of its ease of application, ease of removal, flexibility, lack of adherence to the wound bed on its removal, ability to

Fig 3. Investigator evaluations of the test dressing

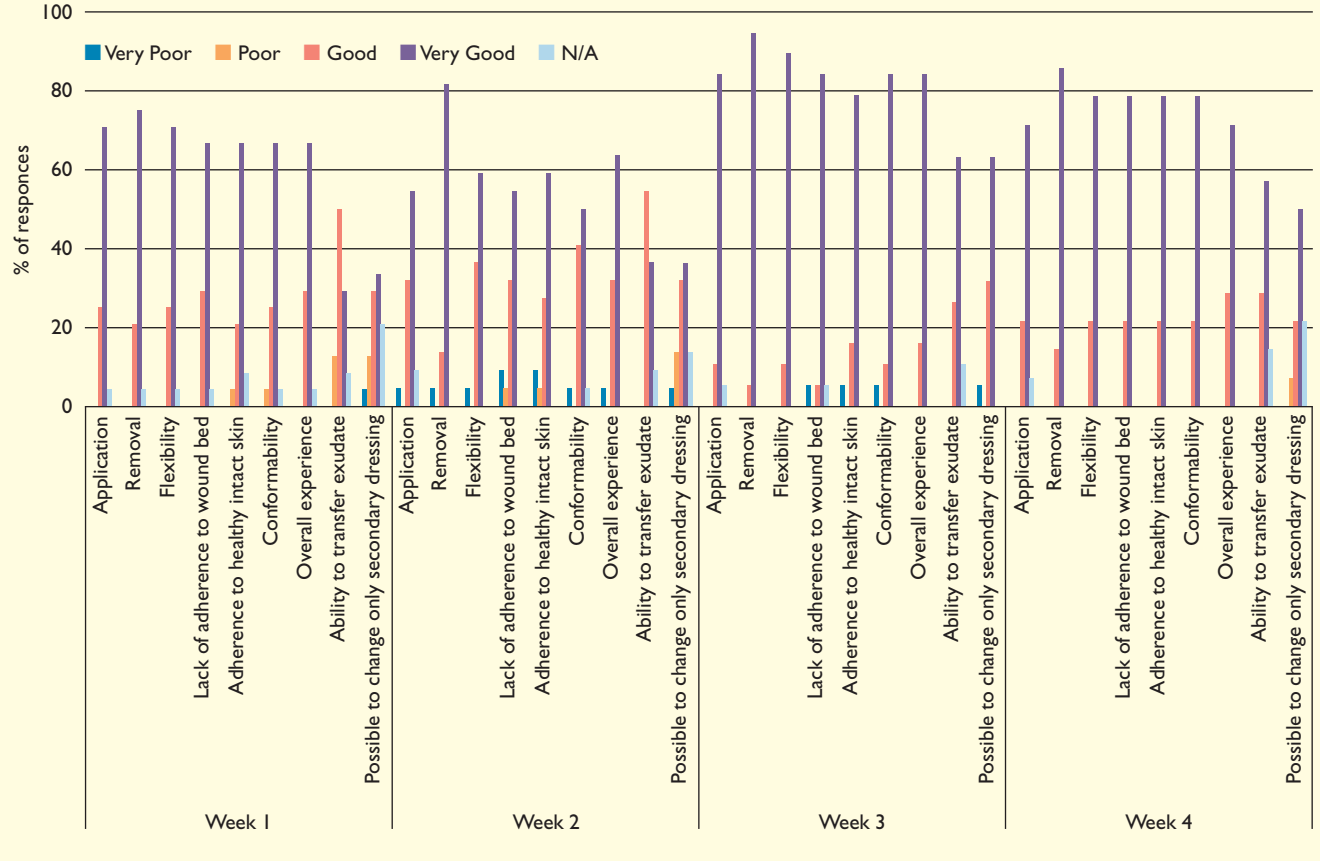
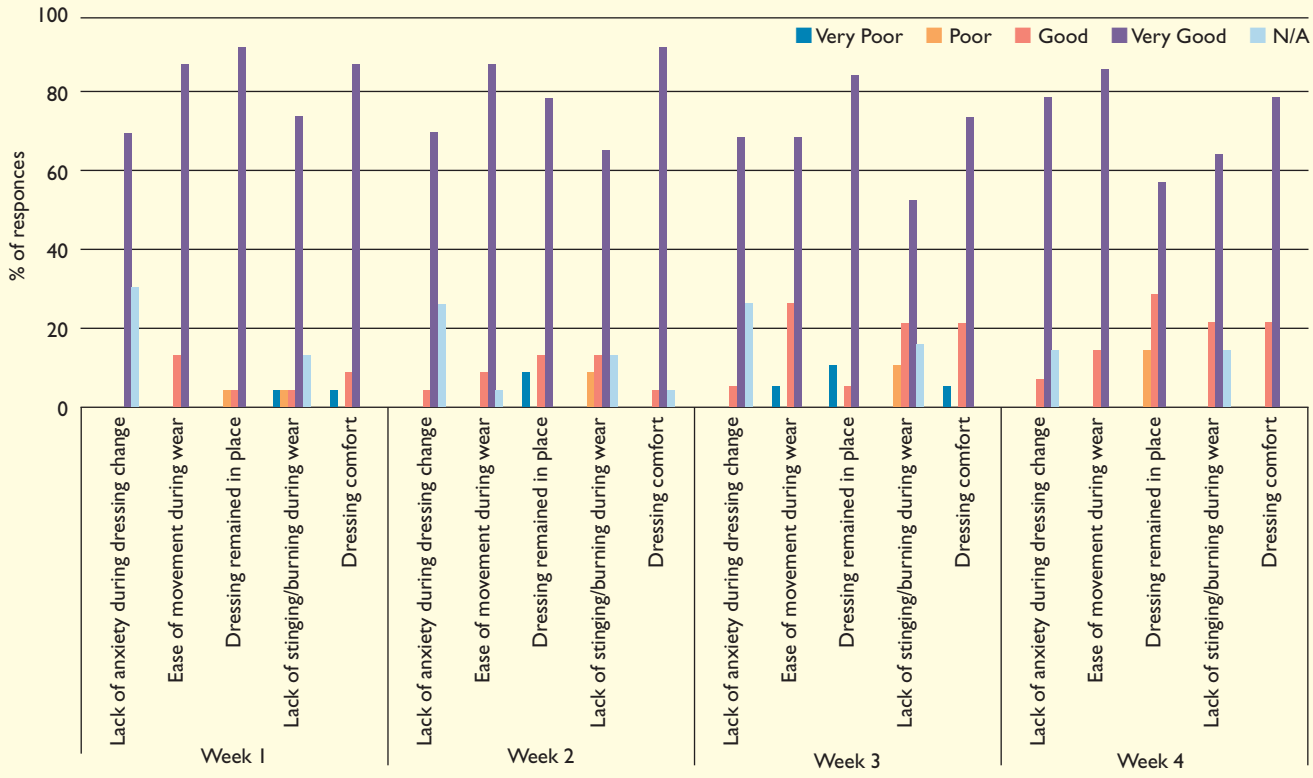


Fig 4. Patient evaluations of the test dressing



adhere to healthy intact skin and conformability. The ability of the dressing to transfer exudate was, on average rated 'good' to 'very good', as was the possibility to change only the secondary dressing (Fig 3).

Patient evaluation of the dressing

The patients were asked to rate the dressings in the following categories: anxiety experienced during dressing change, the ease of movement whilst wearing the test product, dressing comfort, the ability of the dressing to remain in place, and the lack of stinging/ burning experienced during wear. Overall, patients rated these performance parameters as 'very good' (Fig 4).

Serious adverse events

During the study, the clinicians reported that 15 patient's experienced adverse events (AE), e.g. bladder infection, wound infection and increased pain. In some instances patients experienced more than one adverse event. At baseline many of the patients were already known to have a low health status and thus it is perhaps unsurprising that such a population would experience a high number of adverse events. Serious adverse events (SAE) occurred in seven of the patients. In all but one case, an association between the SAE and investigational product was deemed unlikely by the investigators, also one DFU significantly deteriorated, and although any relationship between MTAg and the SAE was not possible to determine, treatment was stopped as a precautionary measure. There were no serious adverse device events reported.

Discussion

This study found that, following treatment with the silver containing wound transfer dressing, MTAg, the signs and symptoms of local wound infection were significantly improved in 23/24 DFUs in this study. In addition, after a post-treatment period, signs of infection were completely absent in the majority of ulcers. The presence of the silver in the dressing would appear to have had a positive effective effect on the bacterial burden of the wound.

In this study, the treated DFUs exhibited encouraging signs of wound healing. The majority of them reduced in size. After treatment with the dressing, the mean size of the DFUs had reduced by 50% and five of the DFU had healed completely; a further six healed completely by the end of the 12 week post-study. This would suggest that MTAg had a positive effect on the healing potential of the DFU.

This study was designed to evaluate the performance and safety of MTAg in the treatment of locally infected DFU. As stated previously, DFUs are a common complication of diabetes mellitus and infection limits their potential to heal. Lavery et al found that

References

1 International Diabetes Federation. IDF diabetes atlas 2014 (6th edn). Available at: http://bit.ly/1iiBkyH (accessed April 2016).

2 Apelqvist, J., Bakker, K., van Houtum, W.H. et al. International consensus and practical guidelines on the management and the prevention of the diabetic foot. Diabetes Metab Res Rev 2000; 16: Supple 1, S84–S92.

3 Chadwick, P., Edmonds, M., McCardle, J.E., Armstrong, D.G. (2014) Best practice guidelines: Wound management in diabetic foot ulcers. Available at: http://bit.ly/1M3lf9d (accessed April 2016).

4 Hilton, J.R., Williams, D.T., Beuker, B. et al. Wound dressings in diabetic foot disease. Clin Infect Dis 2004; 39: Supple 2, S100–S103.

5 Briggs, M., Ferris, F.D., Glynn, C. et al. (2004) Principles of best practice: Minimising pain at wound dressing-related procedures. A consensus document. Available at http://bit.ly/1SlyDst (accessed April 2016).

6 Prompers, L., Schaper, N., Apelqvist, J. et al. Prediction of outcome in individuals with diabetic foot ulcers: focus on the differences between individuals with and without peripheral arterial disease. The EURODIALE Study. Diabetologia 2008; 51: 5, 747–755.

7 Bibic, A., Hamberg, K. Antimicrobial effect of a new silver-containing soft silicone exudate transfer dressing against common wound pathogens in vitro. Poster presented at the 19th Annual Canadian Association of Wound Care, Vancouver, Canada 2013.

8 Marshall-Hanson, C. Use of an absorbent soft silicone antimicrobial exudate transfer foam to treat widespread bullous lesions and erythroderma reaction in a neutropenic patient. Poster presentation at Symposium on Advanced Wound Care (Spring), San Antonio, Texas, United States of America, 2015.

9 White, R. Evidence for atraumatic soft silicone wound dressing use. Wounds UK 2005; 1: 3, 104–109.

DFUs of greater than 30 day duration have a 4.7 times increased risk for infection.[13] Additionally, patients with diabetes may have a greater susceptibility to infections, but the underlying reasons for this remain undetermined.[14–17] Several studies have indicated a potential negative link between hyperglycaemia and an impaired immune response.[18–20]

Although most wounds are contaminated with microorganisms, the majority never become infected. However, when the bacterial burden becomes overwhelming, prompt intervention is important to prevent wound deterioration. Consequently, the timely and aggressive treatment of a DFU suspected of being infected helps prevent progression.

DFU infections are graded as mild, moderate or severe.[11] Mild infections are without signs of systemic toxicity, have only mild surrounding cellulitis and no deep abscesses, but do have two or more signs of local inflammation (exudation, erythema, pain, tenderness, warmth). Effective management of a mild diagnosed diabetic foot infection requires antibiotic therapy, generally one effective against common skin pathogens, for example *Staphylococcus aureus*.[3] However, the use of empirical antibiotic treatments is fraught because of the increasing incidence of antibiotic resistance. In addition, the plasma and tissue pharmacokinetics of antimicrobial agents in patients with diabetes can be affected by the presence of peripheral vascular disease, as well as local and systemic inflammation impairing the target-site penetration.[21]

Topical antimicrobials are progressively being used to provide adjunctive therapy for the management of DFUs. Topical agents can provide a high and sustained concentration of antimicrobial activity at the site of the infection to work alongside, and to help overcome possible reduced antibiotic penetration due to peripheral vascular disease. In addition, topical antimicrobials may limit the potential for any systemic absorption or toxicity, thus reducing the risk of antibiotic resistance.[22] There is conflicting evidence to supporting the therapeutic benefit of dressings impregnated with silver. Several systematic reviews have identified a positive effect of silver dressings on chronic wound healing,[23–26] but others have failed to detect any association.[27–29] All of these authors recognised a future requirement for more rigorous research. In addition, an international consensus document proposed that studies involving silver dressings should consider a more appropriate study endpoint such as the measurement of microbial burden or an assessment of clinical indicators of infection, as opposed to the rate of complete wound healing.[30]

In line with this recommendation, the primary endpoint for this study measured changes in the signs and symptoms of local wound infection present in the target DFU. The limited treatment window with the silver dressing may have provided the impetus to help manage the microbiological burden, providing a more optimal environment for continued healing. However, we acknowledge that because all but one of the patients were taking prescription systemic antibiotics it is impossible to quantify what contribution was afforded by the silver in the test dressing towards antimicrobial activity.

As well as providing antimicrobial activity, a dressing should facilitate wound healing and protect the wound and surrounding skin. One of the mainstays for the management of optimal wound healing is the maintenance of a moist wound environment. Dressings play a key role in wound exudate management, helping to balance the requirement for a moist wound healing environment against the need to avoid maceration of the peri-wound skin. MTAg is a wound transfer dressing that facilitates the movement of wound exudate away from the wound to an appropriate secondary absorbent dressing.[8] Owing to its soft silicone interface, it adheres to intact dry skin but not the moist wound forming a gentle seal that inhibits the movement of exudate onto the peri-wound area, thereby helping to prevent maceration.[9]

The ability of the test dressing to transfer wound exudate to a secondary absorbent dressing was evaluated as 'good to very good' by most investigators. At the baseline assessment, all of the target DFUs were exuding; over 50% of the DFUs had moderate to severe levels of wound exudate. In addition, 75% of the DFU presented with an unhealthy peri-wound skin before any study intervention. Following treatment with MTAg wound exudate levels were substantially reduced and the condition of the peri-wound skin was improved in the majority of ulcers. Following the post-study period 60% of the ulcers were dry and the peri-wound skin area continued to improve. These results suggest that the transfer of wound exudate away from the wound bed to a secondary absorbent dressing helped maintain the integrity of the peri-wound area.

Because DFUs are susceptible to infection, regular wound inspection is an essential part of a patient's wound management regimen. The pain-free removal of dressings and the prevention of further trauma to the wound and the peri-wound skin is recognised as an important consideration in wound management, especially at dressing change, the time of greatest perceived pain.[31] Many wound dressings, both traditional and modern, cause pain and trauma upon their removal, e.g. strong adhesive forces can cause skin stripping, especially where the skin is vulnerable. Pain, and the anticipation of pain, can cause stress for patients and it has been shown that this can delay healing.[32] Dressings with Safetac soft silicone form a bond between the soft silicone interface and the skin surface that allows the dressing to be removed without causing trauma or pain.[33,34] It is now acknowledged that many patients with diabetes, regardless of the presence of neuropathy or neuro-ischaemia, experi-

ence wound pain, particularly during the dressing change process.[35] Throughout this study pain was managed effectively; the mean VAS pain scores during the period of treatment with MTAg, at all of the dressing change assessment points were reduced as compared with the baseline pain assessment and generally patients reported no anxiety at dressing change. The lack of dressing change anxiety felt by the patients may have helped augment the potential for wound healing. In addition, the investigators considered that at dressing change, there was a strong possibility to change only the secondary dressing, leaving MTAg in place, further reducing the risk of dressing-change related pain and possible trauma.

The majority of the patients had a positive experience using MTAg. Patients considered that the dressing was comfortable, remained in place well, while allowing ease of movement during wear. Accordingly, the clinicians who performed the study were highly satisfied with the overall performance of the test dressing, especially its ease of application and removal, flexibility and conformability. Furthermore, the dressing did not adhere to the wound bed but exhibited a very good ability to adhere to the surrounding intact skin.

MTAg was deemed unlikely to be responsible for causing serious adverse events and no serious adverse device events were reported.

Limitations

The main limitation of this study was its non-comparative design. Given the study's positive outcomes, especially in terms of the efficacy and safety of the test dressing, and its potential to provide antimicrobial activity, it would be justifiable to conduct a comparative study to determine the effectiveness of this product with similar products within a larger study population. Possible further investigations could include studies to determine the optimal treatment time required by topical antimicrobials to gain maximal antimicrobial activity.

Conclusion

The results of this study demonstrated the dressing's potential to provide topical antimicrobial activity directly to the infected wound. The use of the dressing lead to significant improvements in the signs and symptoms of local wound infection in all but one of the treated DFUs. Use of the dressing was also associated with reductions in wound size and wound exudation, alongside a considerable improvement of the peri-wound skin condition. MTAg effectively transferred wound exudate away from the wound bed through to a secondary absorbent dressing, alleviating maceration of the peri-wound area. The patients and the investigating clinicians reported an overall positive experience of using MTAg. ■

10 Koerner, S., Adams, D. Use of a soft silicone silver transfer dressing (SSSTD) under compression may manage biofilm and exudate while promoting patient comfort. Poster presentation at the 47th Annual Conference of the Wound Ostomy and Continence Nurses Society, San Antonio, Textas, United States of America, 2014.

11 Lipsky, B.A., Berendt, A.R., Cornia, P.B. et al. 2012 Infectious Diseases Society of America Clinical Practice Guideline for the diagnosis and treatment of diabetic foot infections. Clin Infect Dis 2012; 54: 12, e132–e173.

12 NICE CG 10: (2004) Type 2 diabetes foot problems: Prevention and management of foot problems 2004 - Available at: http://bit.ly/24fudeK (accessed April 2016).

13 Lavery, L.A., Armstrong, D.G., Wunderlich, R.P. et al. Risk factors for foot infections in individuals with diabetes. Diabetes Care 2006; 29: 6, 1288–1293.

14 Muller, L.M, Gorter, K.J., Hak, E. et al. Increased risk of common infections in patients with type 1 and type 2 diabetes mellitus. Clin Infect Dis 2005; 41: 3, 281–288.

15 Peleg, A.Y., Weerarathna, T, McCarthy, J.S., Davis, T.M. Common infections in diabetes: pathogenesis, management and relationship to glycaemic control. Diabetes Metab Res Rev 2007; 23: 1, 3–13.

16 Geerlings, S.E., Hoepelman, A.I. Immune dysfunction in patients with diabetes mellitus (DM). FEMS Immunol Med Microbiol 1999; 26: 3–4, 259–265.

17 Pearson-Stuttard, J., Blundell, S., Harris, T., Cook, D.G., Critchley, J. Diabetes and infection: assessing the association with glycaemic control in population-based studies. Lancet Diabetes Endocrinol 2016; 4: 2, 148–158.

18 Bhattacharya, S.K., Shastri, S., Mahajan, P. et al. Polymorphonuclear leukocyte function in type-2diabetes mellitus patients and its correlation with glycaemic control. Nepal Med Coll J 2007; 9: 2, 111–116.

19 Eliashiv, A., Olumide, F., Norton, L., Eiseman, B. Depression of cell-mediated immunity in diabetes. Arch Surg 1978; 113: 10, 1180–1183.

20 Price, C.L., Hassi, H.S., English, N.R. et al. Methylglyoxal modulates immune responses: relevance to diabetes. J Cell Mol Med 2010; 14: 6b, 1806–1815.

21 Nicolau, D.P., Stein, G.E. Therapeutic options for diabetic foot infections. J Am Podiatr Med Assoc 2010; 100: 1, 52–63.

22 Lipsky, B.A., Hoey, C. Topical antimicrobial therapy for treating chronic wounds. Clin Infect Dis 2009; 49: 10, 1541–1549.

23 Carter, M.J., Tingley-Kelley, K., Warriner, R.A. Silver treatments and silver-impregnated dressings for the healing of leg wounds and ulcers: A systematic review and meta-analysis. J Am Acad Dermatol 2010; 63: 4, 668–679.

24 Leaper, D., Munter, C., Meaume, S. et al. The use of biatain Ag in hard-to-heal venous leg ulcers: meta-analysis of randomised controlled trials. PLoS ONE 2013; 8: 7, e67083.

25 Lo, S.F., Hayter, M., Chang, C.J. et al. A systematic review of silver-releasing dressings in the management of infected chronic wounds. J Clin Nurs 2008; 17: 15, 1973–1985.

26 Lo, S.F., Chang, C.J., Hu, W.Y. et al. The effectiveness of silver-releasing dressings in the management of non-healing chronic wounds: a meta-analysis. J Clin Nurs 2009; 18: 5, 716–728.

27 Chambers, H., Dumville, J.C., Cullum, N. Silver treatments for leg ulcers: a systematic review. Wound Rep Reg 2007; 15: 2, 165–173.

28 Vermeulen, H., van Hatter, J.M., Storm-Versloot, M.N. et al. Topical silver for treating infected wounds. Cochrane Database Syst Rev 2007; 1: CD005486.

29 Storm-Versloot, M.N., Vos, C.G., Ubbink, D.T., Vermeulen, H. Topical silver for preventing wound infection. Cochrane Database Syst Rev 2010; 3: CD006478.

30 Ayello, E.A., Carville, K., Fletcher, J. et al. (2012). International consensus: Appropriate use of silver dressings in wounds. Available at: http://bit.ly/1pykPmO (accessed April 2016).

31 Thomas, S. (2003) Atraumatic dressings. Available at: http://bit.ly/1IG3U90 (accessed April 2016).

32 Soon, K., Acton, C. Pain-induced stress: a barrier to wound healing. Wounds UK 2006; 2: 4, 92–101.

33 Dykes, P.J., Heggie, R., Hill, S.A. Effects of adhesive dressings on the stratum corneum of the skin. J Wound Care 2001; 10: 2, 7–10.

34 Dykes, P.J., Heggie, R. The link between the peel force of adhesive dressings and subjective discomfort in volunteer subjects. J Wound Care 2003; 12: 7, 260–262.

35 Baker, N. Implications of dressing-related trauma and pain in patients with diabetes. Diabetic Foot Journal 2012; 15: 4, Suppl 2, 1–8.