The use of a multimodal wound matrix to treat a variety of hard-to-heal wounds: a case series surveillance

Objective: This case series examines the use of a multimodal wound matrix (MWM) trialled in a selection of clinical practice settings and on a variety of hard-to-heal wounds. The objective was to evaluate the effects of MWM and its performance in managing such wounds, regardless of clinical setting and ulcer type.
Method: Treatment of the MWM was conducted by independent wound care practitioners on wounds that were of >4 weeks duration. Treatment was once a week. Assessment was taken after four weeks and at week 12 of the study to assess percentage area reduction (PAR) compared to baseline measurements taken at the first treatment visit. Complete (100%) re-epithelialisation was also recorded.
Results: A total of 63 wounds were treated with MWM, and ulcer types were grouped as: diabetic foot ulcers (n=21); venous leg ulcers (n=18); pressure injuries (n=10); and others (n=14). Of the wounds, 78% had 100% re-epithelialisation, with an average PAR of 57% at four weeks and 86% at 12 weeks. The average time to resolution for those wounds that closed was 7.9 weeks.
Conclusion: Results from this series of independent case studies support the application of MWM to potentially benefit healing in hard-to-heal wounds of different aetiologies of any duration and in a variety of clinical settings.
Declaration of interest: The authors have no conflicts of interest to declare. The product used in this case series was provided by the study sponsor, Omeza LLC, US.

atypical wounds • diabetic foot ulcer • multimodal wound matrix • multiple aetiologies • pressure injury • venous leg ulcer • wound • wound care • wound dressing • wound healing

The management of hard-to-heal (chronic) wounds is often met with countless challenges across the continuum of care; yet prolonged healing times lead to higher rates of complication, such as infections and amputations, and are a significant healthcare burden.[1,2] When wounds or ulcers remain open, they negatively impact patients' quality of life and can result in significant pain and suffering.[3] Among the most common types of hard-to-heal wounds are diabetic foot ulcers (DFUs), pressure injuries (PIs) (also referred to as pressure ulcers), and venous leg ulcers (VLUs), which are often associated with peripheral neuropathy, immobility and venous hypertension, respectively.[4,5]

Atypical ulcers from inflammatory or haematologic causes, such as pyoderma gangrenosum, hereditary thrombosis syndromes, leg ulcers as a consequence of sickle cell disease, and soft tissue radionecrosis, can also cause significant morbidity.[5]

Individuals who develop hard-to-heal wounds usually have one or more underlying comorbid conditions, such as diabetes, vasculitis, immobility, malnutrition and/or immune suppression, that can negatively affect their innate healing process and increase the risk of their wounds becoming hard-to-heal.[6,7] In addition, ageing affects the innate healing process and, as a result, the prevalence of hard-to-heal wounds is increasing with an ageing population.[4,8]

The following is a collection of case studies examining the use of a multimodal wound matrix (MWM) tested in a selection of clinical practice settings and on a variety of hard-to-heal wounds. The objective was to evaluate the effects of MWM and its performance as well as its versatility in the management of such wounds, regardless of type of clinical setting.

Designed from a clinical perspective and taking a bioactive approach to tackle many of the common pathophysiologies observed in hard-to-heal wounds, the primary concept of the MWM is based on how to stimulate the body to transform the wound microenvironment from a non-healing to a healing state.[9] The concept of the formulation was based on several physiological principles of wound healing. Firstly, the human body is designed to repair and heal wounds, but if stalled in one of the healing phases or deprived of the necessary macronutrients and metabolites for the healing cascade to progress, the wound will not close. Additionally, all hard-to-heal wounds, regardless of their aetiology and associated comorbidities, exhibit common traits, such as

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oedema, biofilm colonisation and decreased local perfusion to the wound, further complicating the innate healing process.[10]

The MWM used in this case series was developed to provide hard-to-heal wounds with the components needed to support the healing cascade, as well as to inhibit bioburden, decrease inflammation and to support regeneration. The formulation is composed of both marine-sourced peptides and omega-3 fatty acids, medium chain triglycerides, plant-sourced polyunsaturated fatty acids, vitamins and minerals. The benefits of omega fatty acids have been well established and along with the cold-water fish peptides are the foundation on which MWM was developed.[9] The physical characteristics of MWM are attributed to other oils and waxes which make the product malleable, and able to intimately connect with the exposed tissue of the irregular wound bed, or fit into tunnelling wounds or where wound undermining occurs.[9]

Methods

The case studies described in this article were conducted by independent wound care certified podiatrists, surgeons, nurse practitioners and dermatologists from clinics geographically spread across the US, from July 2020 through December 2022. Sites of service included physicians' offices, wound care centres, outpatient clinics, and skilled nursing facilities. Sites were chosen to trial the MWM because of the clinician's established clinical wound care experience. The case studies were not part of a registered clinical study but collected as data by the clinicians treating refractory ulcers with MWM. Sites were not provided with a protocol. Clinicians were expected to follow the product's Instructions for Use (IFU) when treating identified patients. Standard of care was not evaluated nor stipulated at the treatment sites but left to the treating clinician's discretion.

Ethical approval and patient consent

The case series was performed in accordance with US and international standards of Good Clinical Practice and Health Insurance Portability and Accountability Act guidelines. Ethics Board approval was not required for these case studies. Prior to study enrolment, all patients provided written informed consent to publish the case details and associated deidentified image assessments.

Patients

The case series population included adult (≥18 years) patients who presented with hard-to-heal wounds of varying aetiologies and durations. Wound types included DFUs, VLUs, PIs, surgical ulcers, arterial ulcers, and atypical wound aetiologies. Patients were followed up to 12 weeks or until wounds had re-epithelialised (measured as 100 percent area reduction (PAR)), whichever came first. Of the patients, one was treated up to 16 weeks.

There were no inclusion or exclusion criteria applied to the patients evaluated in these case studies, except for the contraindications listed in the manufacturer's IFU which include a known sensitivity to cod liver oil and no use on third-degree burns. Case studies included patients who were smokers, opioid and recreational drug users, and those with a body mass index >40kg/m^2.

The target ulcers had been previously treated with standard therapies including offloading, compression therapy and/or moisture managing dressings. The type of offloading for DFUs was left to the clinicians' discretion, based upon the patient's needs. All patients had failed at least one advanced wound care treatment modality, including, but not limited to, hyperbaric oxygen therapy (HBOT), negative pressure wound therapy (NPWT), cellular, acellular, and matrix-like products, and other advanced dressings.

Intervention

Following the manufacturer's IFU, the MWM was generally applied to the ulcer once a week. The wound bed was cleansed and debrided as per clinician decision before the MWM was applied directly to each wound in strips. Approximately 3–5 minutes after application, the MWM was spread evenly throughout the wound. A nonadherent primary dressing was applied to the wound following the application of the MWM. Added absorptive secondary dressings and appropriate modalities, such as compression wraps and offloading devices, were used based on clinician preference.

Treatment was managed in a variety of clinical settings. Data capture of weekly wound measurements was obtained through various methods including automated digital devices, standard photography via handheld devices, and paper ruler measurements. Wounds were assessed weekly and managed with reapplication of the MWM treatment when deemed appropriate by the treating clinician.

Study endpoints and statistical analysis

Study endpoints included PAR of the wound after four weeks of MWM treatment and time to closure with full re-epithelialisation (PAR of 100%). Wounds were measured weekly using either an imaging modality or by a standard method of recording length (L) × width (W) and sometimes, but not consistently, depth (D), with L being the longest length, W the greatest width, and D the greatest depth. Final visit data from patients who had relocated or were non-adherent before the completion of treatment were included in the dataset and analysis.

Data presented in this case series was collected retrospectively. All analyses of data from this study were descriptive (without p-value generation) as the study was not powered for inferential analyses and no formal hypothesis testing was performed.

Results

A total of 63 patients were included in this retrospective case series review. Wound types included: DFUs (n=21); VLUs (n=18); PIs (n=10); and 'others' (n=14; comprising:

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arterial (n=3); surgical (n=2); atypical (n=2); trauma (n=6) and one wound of unknown aetiology) (Table 1).

The age range of the patients in this dataset at the time of treatment with MWM was 31–97 years, with a mean of 72 and a median of 72 years (Table 1). The ratio of male to female patients was equivalent. Wound duration recorded before treatment with MWM ranged from 4–780 weeks (mean: 96.3; median: 30 weeks) (Table 2). Ulcer size ranged from 0.16–72.00cm^2 with a mean size of 9.23cm^2 (Table 2).

Outcomes by wound type

Diabetic foot ulcers

Median age of the patients with DFUs was 63 years (range: 52–84 years) (Table 1). Comorbidities included (but were not limited to): type 2 diabetes; hypertension; hypercholesterolaemia; obesity; congestive heart failure; ischaemic cardiomyopathy; osteomyelitis; renal insufficiency; and chronic kidney disease. DFU area ranged from 0.16–15.4cm^2, with a median size of 1.9cm^2 (Table 2). DFU duration prior to MWM treatment ranged from four weeks to 15 years (780 weeks). Average four-week PAR was 78% (final PAR 88%) (Table 3, Fig 1), with 18/21 patients having a 100% PAR, with a mean healing time of six weeks (range: 3–12 weeks) (Table 3). Of the patients with a DFU, three included in the analysis did not complete treatment: two patients required resolution of a wound infection, and one patient relocated and was lost to follow-up.

DFU case example

An example of a DFU case study treated with the MWM is that of a 65-year-old female patient who presented with a blister of three months' duration that progressed to a hard-to-heal DFU (≥4 weeks duration), exacerbated by a Charcot deformity (Fig 2a). Previous treatments had included collagen powder, gauze covering, absorbent dressing and pressure offloading. The patient's DFU was assessed, treated weekly with MWM (except for a single missed appointment leading to a two-week period between treatment). The DFU was re-epithelialised after eight applications of MWM (PAR of 100% at 10 weeks) (Fig 2b).

Table 1. Patient age distribution by wound type

Ulcer type	Patients, n	Age range, years	Age, median, years	Age, mean, years
DFU	21	52–84	63	64
VLU	18	31–97	67	66
PI	10	70–97	88	85
Other				
Arterial	3	56–87	86	80
Surgical	2			
Atypical	2			
Trauma	6			
Unknown	1			

DFU—diabetic foot ulcer; PI—pressure injury; VLU—venous leg ulcer

Venous leg ulcers

Among the 18 patients with VLUs, the median age was 67 years (range: 54–97 years) (Table 1). Patients presented with comorbidities, including (but not limited to): chronic venous disease; lymphoedema; obesity; venous insufficiency; sarcoidosis; and failed arterial bypass graft (patient required an arterial pump). Ulcer area size in this group ranged from 1.62–72.00cm^2, with a median size of 4.6cm^2, and a wound duration ranging from 12–208 weeks (Table 2). Patients with a VLU received an average of eight treatments with MWM. Average four-week PAR was 54%, and final PAR was 76% (Fig 1). Of the patients, 11 VLUs closed in 12 weeks and one patient's wound had 100% closure at 16 weeks (Table 3). The average time to wound resolution from first application of the wound matrix was 8.5 weeks (Table 3).

VLU case example

A 69-year-old female patient presented upon admission to a skilled nursing facility with a wound of >2 years duration to her right lower extremity. The patient's wound was exacerbated by venous insufficiency and prior trauma to the site. On initial evaluation, the

Table 2. Wound size and duration by wound type

	Ulcer size, cm^2			Ulcer duration, weeks		
	Range	Median	Mean	Range	Median	Mean
DFU	0.16–15.40	1.87	3.18	4–780	21	130.6
VLU	1.62–72.00	4.55	12.75	12–208	32	51.9
PI	0.05–5.81	0.54	1.77	5–208	45	24.0
Other	0.49–74.40	10.13	16.71	6–468	77	83.7
Total	0.16–74.40	3.00	9.23	4–780	30	96.4

DFU—diabetic foot ulcer; PI—pressure injury; VLU—venous leg ulcer

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Table 3. Wound closure rates by wound type

Ulcer type	Total	Closed, n	Closed, %	12-week PAR	4-week PAR	Mean time to resolution, weeks
DFU	21	18	86	88.4	78.0	5.6
VLU	18	12	67	76.3	54.0	8.5
PI	10	7	70	87.7	59.0	7.1
Other	14	11	79	91.9	75.0	6.5
Total	63	49	77	91.9	75.0	6.5

DFU—diabetic foot ulcer; PAR—percentage area reduction; PI—pressure injury; VLU—venous leg ulcer

Fig 1. Multimodal wound matrix treatment results by percentage wound area reduction (PAR) at four weeks and at the end of treatment. DFU—diabetic foot ulcer; PI—pressure injury; VLU—venous leg ulcer

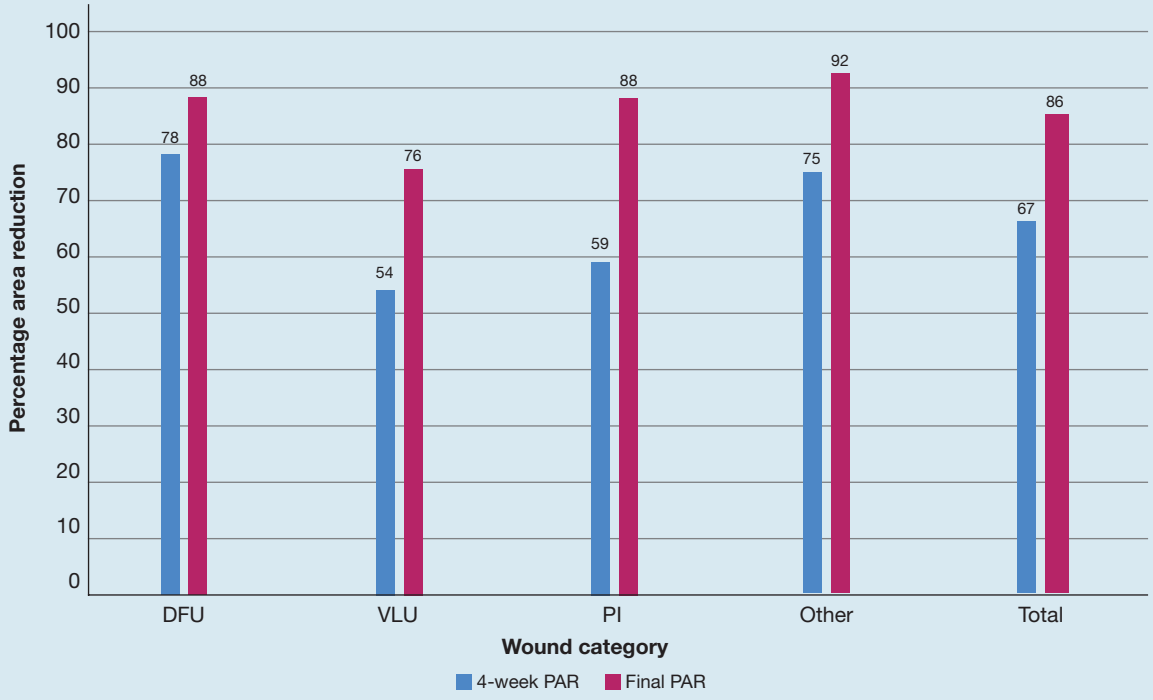
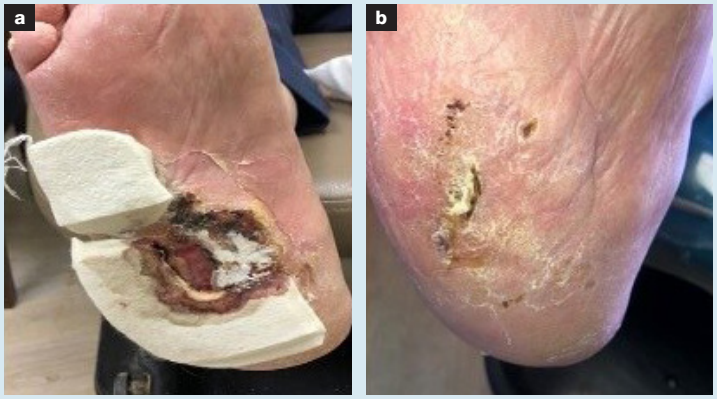


Fig 2. A 65-year-old female patient with Charcot deformity, of 16 weeks duration that was not responding to treatment **(a)**. The wound closed after eight treatments with multimodal wound matrix **(b)**



wound measured 7.08×4.48cm. (Fig 3a). Prior treatment to MWM application had included a polyurethane foam impregnated with a polyvinyl alcohol, an absorbent pad, and dressing changes every other day. After regular treatments with MWM, the PAR had improved by 85%, measuring 3.45cm^2 (Fig 3b). The wound resolved after 15 treatments (Fig 3c).

Pressure injuries

The median age of the 10 patients with PIs was 88 years (range: 70–97 years) (Table 1). Comorbidities included (but were not limited to): neuropathy; congestive heart failure with left ventricular ejection fraction; hypertension; atrial fibrillation; and stage 3 injury. Wound area ranged from 0.50–5.89cm^2, with a median size of 0.54cm^2 (Table 2), and wound duration prior to MWM treatment ranged from 5 weeks to 4 years (208 weeks) (Table 2). Patients previously received

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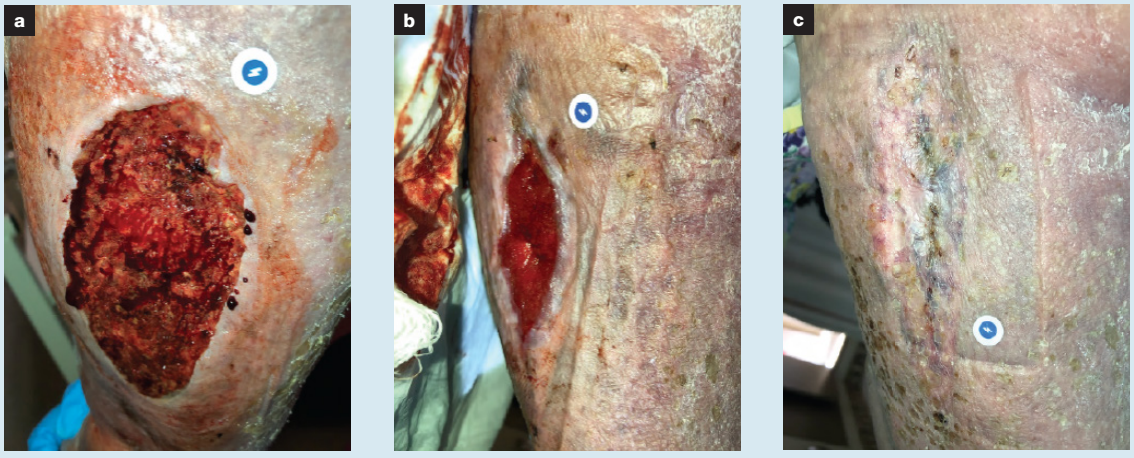
Fig 3. A 69-year-old female patient with a venous leg ulcer on the lower extremity of two years' duration **(a)**. The ulcer after 10 treatments with the multimodal wound matrix (MWM) **(b)**. After 15 weekly treatments with MWM **(c)**



advanced wound dressings to manage their PIs. Average four-week PAR was 59%, and final PAR was 88% (Fig 1). The rate of total wound closure was 70% (7/10) and the average time to wound resolution from first application of the MWM was 7.1 weeks (Table 3). In one PI that was managed with MWM treatment for 12 weeks, a 99% closure was achieved.

PI case example

A 98-year-old female resident of a group home was treated for a left heel ulcer that had been present for >300 days. The patient had lived with dementia and was minimally verbal upon initial evaluation. She was immobile, primarily seen in a wheelchair or bed, and had evidence of peripheral arterial disease. There had been no prior debridement of the PI or consistent offloading to the site. The patient received an initial debridement of callus overlying the wound which measured 2.36×2.59cm (Fig 4a). Her clinician initiated a protocol that included application of MWM to the wound twice weekly and offloading with pillows behind the patient's leg to 'float' the heel. The four-week PAR was 76%, measuring 0.93×1.58cm. At week 12, a final PAR of 99.2% was achieved, with a total of 22 applications over 11 weeks of MWM treatment to the wound (Fig 4b).

Atypical and other aetiologies

Atypical ulcers present with unique characteristics and challenges, requiring accurate diagnosis and subsequent management. These wounds may not respond in the manner expected of more commonly diagnosed wounds, such as VLUs, DFUs or PIs. In this case series, 14 wounds of varying aetiologies were included. The group included patients with sickle cell disease, pyoderma gangrenosum, arterial disease, and hard-to-heal surgical and trauma ulcers. Of the patients, four presented with wounds located on their lower extremities. The age range of the patients was 56–87 years (Table 1). Wounds included in this group had a duration that ranged between 6–468 weeks, with a median of 77 weeks. The size of the ulcers ranged from 0.49–74.42cm^2, with a mean size of 16.71cm^2 and a median size of 10.13cm^2 (Table 2).

Among this mixed group of hard-to-heal wounds, the average four-week PAR was 75%, and the final PAR was 92% (Fig 1). Of the wounds, 11 (79%) healed in an

Fig 4. A 98-year-old female patient with a pressure ulcer of 42 weeks duration **(a)**. Ulcer at week 12 following 11 applications of multimodal wound matrix **(b)**

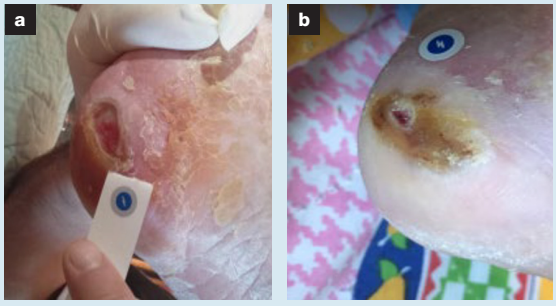
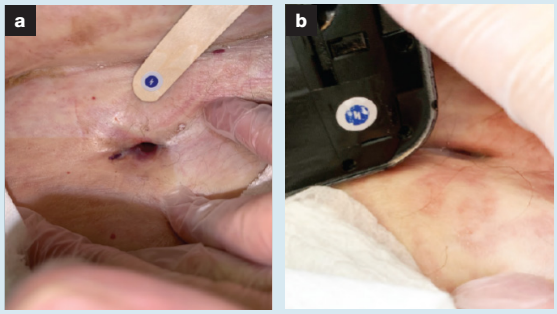


Fig 5. A 79-year-old female patient with a surgical wound of the abdomen that had not responded to >100 weeks of treatment **(a)**. The wound after nine treatments with the multimodal wound matrix **(b)**



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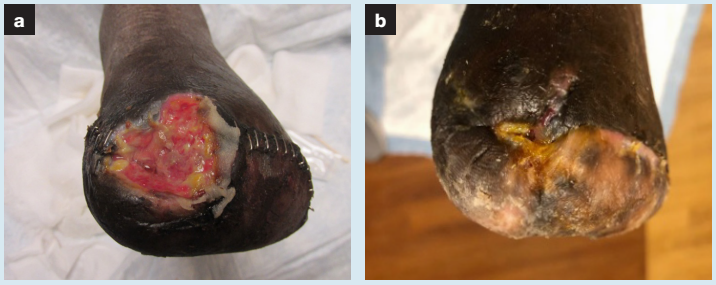
average of 6.5 weeks (Table 3) from start of the MWM weekly applications to resolution.

Atypical ulcer case study examples

Case 1: A 79-year-old female patient with a hard-to-heal, surgical wound of the abdomen with a persistent tunnel was evaluated after approximately two years of prior management. The wound was complicated by the presence of an underlying synthetic mesh that was implanted during the original surgical procedure. Upon initiation of MWM, the wound measured approximately 4.5×1.08×0.91cm (Fig 5a). After four weeks, the measurements had reduced to 0.61×0.41×0.3cm and the wound resolved after nine treatments (Fig 5b).

Fig 6. A 56-year-old male patient who smoked with trauma to a previous amputation of a gangrenous left hallux **(a)**. The wound closed after seven treatments with the multimodal wound matrix **(b)**



Case 2: A 56-year-old male patient, who was a smoker, with a history of diabetes, experienced a left leg trauma to a previous amputation of a gangrenous left hallux. The leg trauma had obliterated the patient's anterior tibial and peroneal arteries, leaving him with a single vessel runoff to the left foot via a posterior tibial artery. The patient had been hospitalised previously to receive intravenous antibiotics and a vascular assessment; a left superficial femoral artery occlusion was identified on an arteriogram and a stent was placed within the vessel. Following discharge, he presented to the wound care centre for follow-up care.

At presentation, the patient's left hallux amputation site was completely necrotic with eschar and he reported significant rest pain of the distal left foot (10/10). A referral was made by the attending physician for adjunctive HBOT and for smoking cessation assistance. The patient's pain was not alleviated by these interventions, and he was referred for additional vascular and podiatric surgery consultations. The patient was subsequently admitted to the hospital where he underwent a left transmetatarsal amputation. After discharge to home, he resumed outpatient HBOT for the original hard-to-heal left hallux amputation wound. A freshly stapled lesser digit amputation incision was present in addition to the periwound skin, which was darkly pigmented and dusky, and with continued hyperalgesia. These findings negated him as a candidate for subsequent NPWT. At this time, with the wound measuring 3.4×3.4cm, the MWM application was initiated and applied to the site every 5–7 days (Fig 6a). After three applications, there was significant improvement in the wound depth/tissue colour, with visible re-epithelialisation at the wound edges. Despite the patient's obvious ischaemia, a PAR of 65% was attained after four applications. The wound improved with each treatment and closed after the seventh application of MWM (Fig 6b). He was discharged from the wound specialist's service <2 months after the initial MWM application.

Discussion

While the underlying comorbid conditions contributing to the development of various acute and hard-to-heal wounds may be patient specific, the basic tissue reparative process is similar, regardless of the wound location on the body. The healing cascade contains a series of complex and coordinated events that include: phagocytosis; damaged extracellular matrix degradation; angiogenesis; neocollagenesis; and tissue remodelling.[4] Commonalities therefore exist in the care of these wounds, regardless of type or place of treatment. However, although there are guidelines for standard of care for hard-to-heal wounds, we nevertheless accept that the standard treatment at wound care sites can vary, primarily due to available resources at each site. For example, topical product availability to clinicians is often based on contracts within a healthcare system or determined by clinician preference. Parameters for consideration and guidelines are widely accepted and implemented, but not always carried through. For example, offloading for DFUs may limit a patient's ability to work or drive a car, and therefore the decision to implement may need to be adapted to meet the patient's basic needs.

The case studies described here include hard-to-heal ulcers that failed to progress into a healing trajectory, despite the use of previous advanced therapies and standard treatment. The phrase 'real-world evidence' to describe the data is not included here because these words hold a specific definition in clinical research, but these case studies are intended to reflect the everyday challenges faced in wound care settings. The ulcers in this series are unlikely to qualify for clinical trials because of the age of the wounds and the patients' extensive comorbidities, but they are representative of cases routinely seen in US wound clinics. The 63 complex wounds had a range of underlying conditions including ischaemia, diabetes, venous stasis disease, or constant pressure. Nevertheless, 77% of the ulcers closed in an average time of seven weeks, with a mean four-week PAR of 57% and a 86% PAR at 12 weeks (Table 3). The results described in this case series illustrate the ability of the MWM to support wound repair across the phases of wound healing in a wide variety of ulcers regardless of aetiology.

The current global wound care product market is an immense commercial enterprise, with revenues exceeding $22.25 billion USD.[11] Yet it is primarily

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comprised of singularly focused advanced wound care treatments, such as products used mainly for infection control, tissue debridement or exudate management.[12–14] While these therapies have benefit, they may only have utility in certain patients or specific wound types. Additionally, autologous and allograft tissue therapies used in the treatment of complex wounds have limitations of cost, accessibility, procedural pain, contradictory evidence, and wound exclusion based on aetiology.[15] Leveraging multimodal products able to address a myriad of core local factors contributing to delays in wound healing are pivotal in supporting successful outcomes in this complex patient population. The development of the MWM was born out of this need.

Prior to these clinical studies, the safety of the MWM was assessed in clinical trials (registered clinical trials numbers: NCT4510376; NCT04510675; AND NCT04512274), where it showed no potential allergenicity or sensitisation, and no known product-related adverse events. The active ingredients of the product are sustainably sourced.[9] The formulation is composed of components that have supporting research, showing properties that have reported antimicrobial, anti-inflammatory and angiogenic factors. Omega fatty acids and other nutrients contained in the MWM have been studied extensively by researchers and their respective benefits have been validated well before the product was developed.[16] The composition and physical qualities of MWM, such as melting point and being anhydrous, are also design-specific features to deliver the active ingredients to the wound bed as a slow bolus and to promote the healing process.[9]

Modern wound care is delivered in a wide variety of settings by multidisciplinary providers, including a growing mobile wound care sector. Some advanced wound care therapies require special handling and storage (freezer/refrigerator), making them less than ideal for use in care settings not associated with hospital or clinic facilities. Use of the MWM in this limited series illustrated ease of product use, with an ability to convert previously recalcitrant wounds to a healing trajectory. Wider adoption of the MWM could provide substantial clinical improvement to the current standards of care and other advanced modalities. Versatility of the product was also observed as the types of wounds treated in this study reflected a range of aetiologies typically encountered in settings where wounds are commonly managed.

This case series provides background knowledge behind the development of the MWM and its potential for treatment in hard-to-heal wounds. Having treatments that are suitable for use across the continuum of care is of increasing importance. As our population ages, the number of patients with hard-to-heal wounds continues to rise. Shelf-stable, easy to use, patient-friendly products, such as the MWM, are a welcome addition to the wound care armamentarium.

Limitations

The major limitation of this data is that treatment was provided with no protocol, inclusion or exclusion criteria, nor standardised reporting. It is a collection of surveillance data from independent practitioners using a variety of methods to collect wound measurements and patient information in different care settings.

Another limitation is that there is variability in the aspects of care at the case studies' sites which affects evaluation of the treatment outcome of MWM. Future studies are needed to increase the patient population and results compared to structured clinical trials to reduce potential inherent bias.

Conclusion

The results of this case series support the potential use of this MWM for multiple wound types of any duration that are failing to respond to alternate treatments. To evaluate the effects of the matrix in a more controlled setting with standardised treatment, three clinical trials are being conducted for the treatment of DFUs, for refractory VLUs, and for wounds/ulcers of multiple aetiologies. Results and data from ongoing and future controlled clinical trials will provide data to further evaluate the efficacy and the limitations of the wound care matrix in the treatment of hard-to-heal wounds. JWC

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References

1 Nussbaum SR, Carter MJ, Fife CE et al. An economic evaluation of the impact, cost, and medicare policy implications of chronic nonhealing wounds. Value Health 2018; 21(1):27–32. https://doi.org/10/1016/j.jval.2017.07.007
2 Sen CK. Human wounds and its burden: an updated compendium of estimates. Adv Wound Care 2019; 8(2). https://doi.org/10.1089/wound.2019.0946
3 Olsson M, Järbrink K, Divakar U et al. The humanistic and economic burden of chronic wounds: a systematic review. Wound Repair Regen 2019; 27(1):114–125. https://doi.org/10.1111/wrr.12683
4 Falanga V, Isseroff RR, Soulika AM et al. Chronic wounds. Nat Rev Dis Primers 2022; 8(1):50. https://doi.org/10.1038/s41572-022-00377-3
5 Larouche J, Sheoran S, Maruyama K, Martino MM. Immune regulation of skin wound healing: mechanisms and novel therapeutic targets. Adv Wound Care (New Rochelle) 2018; 7(7):209–231. https://doi.org/10.1089/wound.2017.0761
6 Kirsner RS, Vivas AC. Lower-extremity ulcers: diagnosis and management. Br J Dermatol 2015; 173(2):379–390. https://doi.org/10.1111/bjd.13953
7 Nickles M, Tsoukas M, Sweiss N et al. Atypical ulcers: a stepwise approach for clinicians. Wounds 2022; 34(10):236–244. https://doi.org/10.25270/wnds/21060
8 Gould L, Abadir P, Brem H et al. Chronic wound repair and healing in older adults: current status and future research. Wound Repair Regen 2015; 23(1):1–13, https://doi.org/10.1111/wrr.12245
9 Bettle G, Bell DP, Bakewell SJ. A novel comprehensive therapeutic

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approach to the challenges of chronic wounds: a brief review and clinical experience report. Adv Ther 2023; 41:492–508. https://doi.org/10.1007/s12325-023-02742-4
10 Demidova-Rice TN, Hamblin MR, Herman IM. Acute and impaired wound healing: pathophysiology and current methods for drug delivery, part 1: normal and chronic wounds: biology, causes, and approaches to care. Adv Skin Wound Care 2012; 25(7):304–314. https://doi.org/10.1097/01.asw.0000416006.55218.d0
11 Grand View Research. Wound care market size, share & trends analysis by product (Advanced, traditional), by application (chronic wounds), by end-use(hospitals, nursing homes), by mode of purchase, by distribution channel, by region, and segment forecasts, 2024–2030. 2024. https://tinyurl.com/4fsypykd (accessed 27 August 2024)
12 Iqbal A, Jan A, Wajid MA, Tariq S. Management of chronic non-healing wounds by hirudotherapy. World J Plast Surg 2017; 6(1):9–17
13 Mahmoudi M, Gould L. Opportunities and challenges of the management of chronic wounds: a multidisciplinary viewpoint. Chronic Wound Care Manage Res 2020; 7:27–36. https://doi.org/10.2147/CWCMR.S260136
14 Wu S, Carter M, Cole W et al. Best practice for wound repair and regeneration use of cellular, acellular and matrix-like products (CAMPs). J Wound Care 2023; 32(Sup4b):S1–S31. https://doi.org/10.12968/jowc.2023.32.Sup4b.S1
15 Snyder R, Ead K. A comparative analysis of the cost effectiveness of five advanced skin substitutes in the treatment of foot ulcers in patients with diabetes. Annal Rev Res 2020; 6(1):555678. https://doi.org/10.19080/ARR.2020.06.555678
16 Silva JR, Burger B, Kuhl CM et al. Wound healing and omega-6 fatty acids: from inflammation to repair. Mediators Inflamm 2018; 2503950. https://doi.org/10.1155/2018/2503950

Reflective questions

- How effective can a multimodal approach be for wounds of multiple aetiologies?
- Which hard-to-heal wound aetiologies could benefit most from marine-sourced products?
- What are the common challenges to healing hard-to-heal wounds faced by health professionals, irrespective of care setting?

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