REVIEW

Antimicrobial activity of non-medicated HydroClean®, a hydro-responsive wound dressing (HRWD™) – a narrative review of the evidence

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Abstract
Aims To present recent evidence for the antimicrobial effect of a non-medicated wound dressing in wounds. Methods: An electronic search of key terms ("HydroClean" and "HRWD") was undertaken in articles published between 1 January 1990 and 31 March 2024. Results: In all, seven articles met the inclusion criteria. Two articles were related to experimental studies, and the remaining five articles described clinical studies featuring non-medicated wound dressings. Conclusions: Non-medicated wound dressings' (HydroClean®) effectiveness in exudate management includes the absorption and sequestration of damaging exudate components such as matrix metalloproteinases. Hydro-responsive wound dressings (HRWD™) promote removal of devitalised tissue which is a focus of microbial growth (such as wound biofilm), and results in a reduction in the clinical signs of infection. Non-medicated wound dressings that contain no active antimicrobial agent may be used to treat infected wounds via the physical characteristics of the dressing.

Keywords debridement, hydro-responsive, wound bed preparation, wound cleansing
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Introduction
Challenges of treating chronic wounds: Chronic wounds present challenges which require various treatment approaches including the use of dressings to manage, for example, differing levels of exudate, the presence of devitalised tissue and infection.[1]

Exudate production: A common feature of many chronic wounds is the presence of elevated levels of wound exudate that has a different composition from acute wound fluid. Elevated exudate levels can occur due to the underlying pathology of the patient or the presence of wound.[2] The damaging nature of chronic wound exudate is due (in part) to elevated levels of matrix metalloproteinases (MMPs), which contribute to aberrant tissue destruction and peri-wound skin excoriation.[3] Additionally, in infected wounds, the presence of microorganism-derived MMPs also contributes to the elevated enzyme activity levels, and exacerbates the detrimental effect of exudate in chronic wounds.[4]

Devitalised tissue (necrosis and slough: The presence of devitalised tissue in the wound impairs healing progression.[5] This devitalised tissue creates optimal conditions for bacterial growth which hinders healing.[6] Debridement, the removal of devitalised tissue, is imperative for enabling healing progression.[7] Autolytic debridement is one such way that this tissue may be removed.[5] It is a natural process by which endogenous phagocytic cells and proteolytic enzymes break down devitalised tissue, such as slough and necrotic tissue. Additionally, the establishment of a moist wound environment promotes autolytic debridement processes and promotes healing.[5]

Infection: Skin wounds, acute and chronic, can enable microbial (pathogenic bacteria, fungi, virus or protozoa) access to the underlying tissue where the environment can support microbial migration and proliferation.[8] In some wounds (especially chronic wounds) this bacterial contamination can lead to colonisation and infection (local

or systemic) which will delay healing or adversely affect the patient or their wound.[8] Some specific underlying ulcer pathologies and/or comorbidities, such as venous leg ulceration and diabetic ulcers, have a high incidence of infection.[9,10] Chronic wound infections may delay the healing process, with clinical implications (increased pain, reduced quality of life) and a significant burden on healthcare systems.[7] For example, hard-to-heal wounds such as diabetic foot ulcers, venous leg ulcers, and pressure ulcers/injury add a considerable economic healthcare costs.[11] The presence biofilm (aggregations of microbial cells surrounded by a polymer matrix) in chronic wounds has been estimated to be 80% and play a role in the significant challenge of antimicrobial resistance.[12]

Meeting the challenges using wound dressings: A myriad of wound dressings have been developed to meet the challenges of exudate production, a build-up of devitalised tissue in the wound bed, and the presence of infection.[13]

Elevated wound exudate: Wound exudate control in chronic wounds is one challenging aspect of wound management and several different dressing types have been developed (Table 1). Additionally, provision of a moist environment enables healing progression when compared to traditional wound dressings,[13] but this must be balanced by the necessity to manage chronic wound exudate and its components such as matrix metalloproteinases (MMPs).[14] Superabsorbent polymers (SAP), are a group of materials that have been used in wound dressings, and their use has been reported to have a number of beneficial properties[15] such as:

- High absorption capacity
- Biocompatibility
- Capacity to create an osmotic gradient
- Gel-forming ability
- Ability to capture harmful ions
- Ability to absorb and "lock in" fluids, bacteria, MMPs, and other damaging species (such as reactive oxygen species) within the dressing

SAP dressings are designed to absorb and retain wound fluid and clinical studies have demonstrated that SAPs can be used to treat wounds such as chronic wounds (such as venous leg ulcers, diabetic foot ulcers, pressure ulcers), and acute wounds such as burns, surgical or traumatic wounds that produce moderate to high volumes of exudate.[16,17] These dressings have been shown to absorb and sequester bacteria,[18,19] proteolytic enzymes such as MMPs[20-23] and neutrophil elastase.[17,23,24] Overall, these wound dressings enable wound healing progression,[16,19,25,26-29] and improved quality of life,[27-29] leading to cost savings.[27,28,30]

One such dressing containing SAP is HydroClean® (HARTMANN, Germany), a Ringer's solution-activated polyacrylate (PA)-containing dressing that has been termed a "hydro-responsive wound dressing" (HRWD™). This dressing has been specifically developed to meet the challenges of chronic wounds. This HRWD™ dressing can deliver or absorb moisture as required, depending on the environmental fluid balance of the wound,[31] via a balanced isotonic solution containing a mix of sodium, potassium, and calcium salt solutions. These HRWD™ as well as offering excellent exudate management, are also able to manage infection without using any active antimicrobial agent. Instead, bacterial load is reduced via physical means.

Removal of necrotic tissue: In order to remove necrotic tissue, autolytic debridement is a successful and "tissue friendly" method.[32] It has been demonstrated that HRWD™ have strong hydro-responsive properties, not only to absorb large fluid volumes but also deliver Ringer's solution to the wound enabling autolytic debridement. This process softens, loosens, and rinses out necrotic tissue and fibrinous coatings while absorbing bacteria and protein-laden exudate.[25] A number of clinical studies have demonstrated the excellent debridement properties of HRWD™.[33]

Infection control: If wound infection is present, it is imperative it is treated as soon as possible generally using antimicrobial agents, such as antibiotics or antiseptics. However, there is controversy about the use of topical antibiotics due to antimicrobial resistance,[34] also some antiseptics may have localised toxic effects on the wound/peri-wound tissue.[35] An alternative approach is to use a wound dressing that acts by a physical means, for example wound dressings (such as HRWD™) that can absorb and sequester microbes

Table 1. Main dressing types developed for exudate management

Dressing type	Exudate management
Hydrogels	For dry to low exuding wounds – moisture donating dressings that help maintain a moist wound environment and aid in autolytic debridement but are not suitable for heavily exuding wounds
Hydrocolloids	For low exuding wounds – moisture donating dressings with limited absorbency, maintain a moist wound environment but may cause maceration
Alginates	For moderate to highly exuding wounds – they help maintain a moist environment and are not suitable for dry wounds
Gelling fibres	For moderate to highly exuding wounds – absorbent and help maintain a moist environment
Superabsorbents	For highly exuding wounds – can prevent maceration, some of these dressing also maintain a moist environment, supporting wound healing and debridement

within its SAP structure and can then be removed when the dressing is changed. Evidence supporting the use of HRWD™ has been presented in early laboratory-based studies using cultures of common wound microorganisms e.g., *Staphylococcus aureus, Staphylococcus epidermidis, Pseudomonas aeruginosa, Candida albicans*.[36] Various wound pathogens, especially gram negative bacteria and certain antimicrobial-resistant microorganisms,[18] have been classified by the World Health Organisation as "priority organisms." These are the microorganisms that pose the greatest threat to human health.[37]

This narrative review examines published evidence relating to the non-medicated superabsorbent wound dressing, HydroClean® (HRWD™), and its antimicrobial effect.

Methods

Narrative reviews are non-systematic reviews of a subject. They describe what is known on a topic while conducting a subjective evaluation and critique of evidence.[38] This narrative review was conducted in a semi-formal process and included several stages: defining the research question; identifying relevant studies; study selection; summarising and reporting the results. The research question was defined using the PEO framework (Table 2), which we considered an appropriate framework for our review.[39] The PEO framework breaks the topic of our review into three separate areas: the **P**opulation to focus on in the review, the **E**xposure (the issue of interest), and the **O**utcomes or themes to examine. Once the scope of the review – to review the evidence for the antimicrobial activity for non-medicated HydroClean®– was defined relevant studies were identified. The PRISMA framework was used for reporting the results (Figure 1).

Search strategy and eligibility criteria

The electronic database MEDLINE (accessed through PubMed) was searched for relevant articles that were published between January 1990 (no HydroClean®-related evidence available prior to this date) and March 2024 to identify studies reporting data on the use of HydroClean® dressings on the management of wounds. MEDLINE is a powerful search tool for medical literature[40] and is freely available. Studies have suggested that searching only one database can be sufficient[41,42] particularly for non-systematic reviews.[43] The scope of MEDLINE and evidence that suggests that searching of multiple databases may not be necessary to identify all relevant references to draw valid conclusions.[44] Additionally, the reference lists of relevant studies were hand-searched and relevant articles were included.

The search strategy was ""hydroclean"[All Fields] OR "hrwd"[All Fields]". Inclusion criteria included primary evidence studies reporting antimicrobial activity of non-medicated HydroClean®, laboratory and clinical studies, articles written in the English language. Exclusion criteria included any articles that only featured PHMB-containing HydroClean® Plus, review articles, and papers not published in the English language. Older iterations of the dressing were also excluded from this assessment.

Table 2. PEO framework to identify the research question

Population	Patients and pre-clinical studies
Exposure	Wound infection
Outcome	Antimicrobial activity

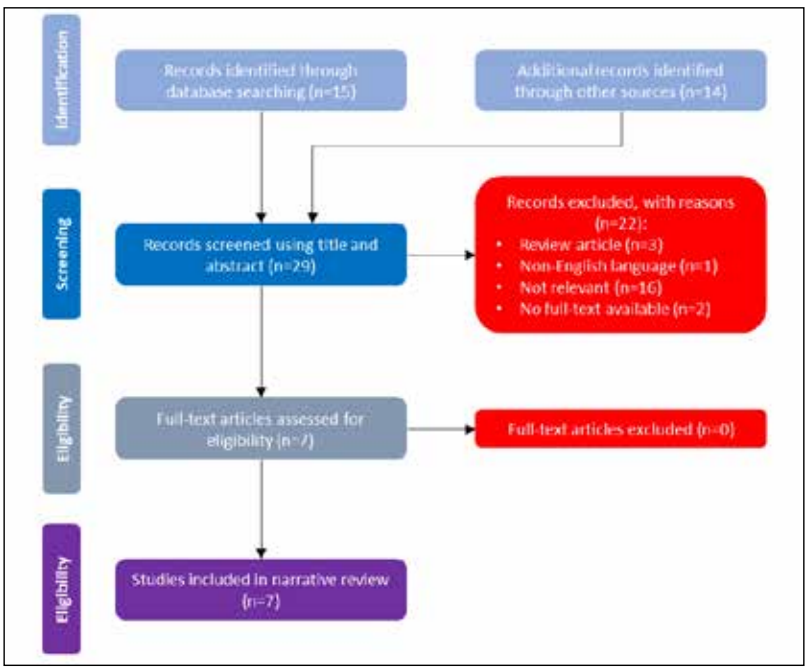

Figure 1. PRISMA flow diagram to indicate the search results based upon the search strategy

Study selection, data extraction, and analysis

The process for study selection is outlined in the PRISMA flow diagram (Figure 1). The titles and abstracts of each result was screened against the inclusion and exclusion criteria. Full texts of articles meeting the inclusion criteria were independently assessed by two authors (MR and AR). Following full-text screening, studies that met the inclusion criteria underwent data extraction. Collated information included the following data points: study aims and objectives; design and methodology; sample size; wound types; details of the outcome measures; and main study results (Table 3). The primary outcome was the impact on wound debridement and infection control, secondary outcomes were wound progression, quality of life (such as pain scales), and MMP activity.

Results

The findings were summarised and described narratively, under various collective headings based upon outcomes.

The search identified 15 potential records, and records from other sources (such as hand searching) (n=14) were added, resulting in 29 records. Following review of titles and abstracts, seven full text articles were retrieved and included in the narrative review (Figure 1), including five observational studies, and two laboratory-based studies (Tables 4 and 5).

Discussion

HWRD in exudate management

The exudate absorption capacity of polyacrylate superabsorbent polymers (SAP) is well known and none of the included studies specifically assessed fluid handling capacity. Two studies in this review (one clinical[45] and one laboratory based[22] discussed the absorption of exudate components, such as matrix metalloproteinases (MMPs). Eming et al[22] conducted a series of in vitro studies to assess whether polyacrylate superabsorber particles from HRWD™ could block MMP activity in wound fluid obtained from chronic venous leg ulcers. Wound fluids from six patients were collected, and in three patients HRWD™s were used to evaluate whether MMPs bind to the PA particles in vivo. Initial experiments incubating wound fluid with PA for two hours showed that PA inhibited MMP-2/9 activity by more than 87% (p=0.009), and that there was clear binding of MMPs to the particles. This binding resulted in a reduction of MMP activity compared with untreated wound fluid. Further experiments suggested that the inhibitory activity of PA particles did not require direct physical contact of the MMPs and the particles. Rather the data indicate that MMPs can be inhibited in an indirect fashion, in that Ca^{2+} and Zn^{2+} (cofactors necessary for MMP activity) bind to the PA particles and are no longer available for MMP activity. The binding of MMPs to wound dressings was assessed in clinical samples. Dressings that had been previously used to treat chronic venous leg ulcers were collected and PA particles from the wound-facing aspect of the dressing were analysed for MMPs. Enzyme assays indicated that MMPs bound efficiently to PA particles of the HRWD™. The study authors concluded that the PA particles of HRWD™ can rescue the highly proteolytic microenvironment of non-healing wounds from MMP activity, activity that may include bacterial MMP activity, and that more conductive conditions allow healing to proceed.

Mikosiński et al[45] undertook a multicentre, prospective observational study evaluating biomarkers in wound fluids. This method was used to monitor wound progression in a sample of 57 patients with venous leg ulcers treated with HRWD™. Protein expression patterns were recorded for a 12 week period and, in addition to wound area, measurements showed several biomarkers had been absorbed and retained by the dressings. Levels of proteinases MMP-2, MMP-9, and neutrophil elastase – all proteinases associated with inflammation and/or infection – were assessed over the course of the assessment period. Neutrophil elastase, MMP-2, and MMP-9 activity were all measured in HRWD™-extracted samples indicating that the dressing matrix readily absorbed these proteinases. Binding of proteinases to the dressing was efficient enough that the investigators were confident in using the uptake and binding of biomarkers, such as proteinases, as an indicator of the status of the progression of these wounds. The investigators noted a steep decrease in abundance within the first two weeks for neutrophil elastase and MMP-2. Starting median values for neutrophil elastase were 21.3 arbitrary units (AU), decreasing to 3.0 AU (p<0.001). For MMP-2, median values decreased from 26.2 AU at the start to 10.3 AU at 2 weeks (p<0.001). In contrast, MMP-9 remained almost unchanged throughout the study.

Table 3. Main article assessment criteria

Criteria	Summary
Aims/objectives	Articles reporting on antimicrobial activity of non-medicated HRWD™
Design/methodology	Only reporting primary pre-clinical and clinical evidence
Wound type	Skin wounds (acute and chronic wounds)
Outcome measures	Outcome measures as set out in study methodology related to antimicrobial activity and wound progression/healing
Main results	Results related to stated outcome measures

Table 4. A summary of the included studies evaluating HRWD™ treatment for wounds

Reference	Study type; setting (where stated)	Dressing type	N (m, f) age (± SD)	Wound type(s)	Main outcome measures	Main results
Sterpione et al, 2021[50]	Open-labelled, non-comparative study; community or nursing home	HydroClean®	86 (38, 48) 67.7 ± 21.7	Acute and hard-to-heal wounds including venous leg ulcers, arterial ulcers, diabetic foot ulcers, and pressure ulcers	• Assessment of wound healing progression (as measured by PUSH score) • Pain experienced at dressing change • Assessment of wound severity • Wound response to treatment • Clinical signs of infection • Ease of use of dressing • Performance of dressing (ease of use, patient acceptability)	• Wound progression as measured by a decrease in PUSH score from a mean of 11.9±2.9 to 7.0±4.5 ($p<0.0001$) • Decrease in wound size (median 12.0cm² to 2.8cm², $p=0.0069$) • Decrease in wounds with exudate (95.3% to 59.3%, $p<0.0001$) • Decrease in percentage of wounds with predominantly devitalised tissue (84.7% to 11.8%) • Increase in granulation tissue (15.3% to 88.2%) ($p<0.0001$) • Only 20% (62/310) of dressing removals resulted in pain (>30mm, Visual Analogue Scale, VAS) • Proportion of infected wounds decreased over study period (19.3% to 3.6%, $p<0.01$) • Ease of use rated very good/good by >95% clinicians
Goedecke et al, 2022[49]	Open, prospective, non-comparative observational study	HydroClean®, HydroClean® mini	278 (128, 140) 67.5 ± 16.2	Acute and hard-to-heal wounds	• Level of slough • Granulation tissue formation • Assessment of wound progression (wound size) • Local signs of infection • Pain	• Wound size decreased • Wound area covered by slough decreased • Wound area covered by granulation tissue increased • Improvement in local signs of infection, pain experienced, and peri-wound skin condition
Mikosiński et al, 2022[45]	Open, prospective observational study; specialised clinic	HydroClean®	57 (26, 31) 69.2 ± 11.9	Venous leg ulcer	• Levels of fibrin and necrotic tissue • Wound area (WAR)	• Wound area coverage by devitalised tissue decreased • Wound area reduction as measured by WAR (absolute and relative)
Candas et al, 2021[31]	Case series; hospital or specialised clinic	HydroClean®	3 (0, 2 [1 not stated]) 70.5 ± 26.2	Leg ulcers, pressure ulcer	• Wound debridement • Granulation tissue • Pain	• Reduction in levels of slough • Increase in levels of healthy granulation tissue • Reduced pain
Yeh et al, 2019[51]	Case series; in-patient and out-patient	HydroClean® mini	6 (4, 2) 57.5 ± 34.4	Diabetic foot ulcer, pressure ulcer, non-healing traumatic wound	• Wound debridement • Granulation tissue formation • Wound progression	• Removal of devitalised tissue • Wound progression (wound area reduction) • Increase in granulation tissue

MMPs secreted from connective tissue cells and inflammatory cells play an important role in degradation and remodelling of extracellular matrices under physiological and pathological conditions.[46] Many protein-degrading enzymes are present in excess in chronic, non-healing wounds, and the elevated levels of these destructive enzymes results in the breakdown of wound and peri-wound tissues through the breakdown of the tissue's extracellular matrix.[14] As well as these inflammatory-based proteases resulting in the destruction of wound and peri-wound tissues, these enzymes can result in the destruction of protein-based growth factors and cytokines.[47] The resultant destruction leads to delays in epithelialisation and a lack of healing.[47] Bacterial proteinases may play an important role in tissue destruction and disintegration of extracellular matrix at the site of infections[48] through the release of bacterial proteases, and by intensifying the pro-inflammatory environment of the wound thus stimulating further the production of host-derived proteases. The studies of Eming et al[22] and Mikosiński et al[45] together indicate the uptake and sequestration of proteases such as MMPs by the polyacrylate-based superabsorbent polymer of non-medicated HRWD™.

HRWD™ and debridement

Five observational studies discussed the efficacy of HRWD™ in the debridement of wounds of varying aetiologies.[31,45,49-51] These case series ranged in size from three patients to 278 patients. Goedecke et al[49] reported the largest group of patients and included wounds of varying aetiologies. The largest proportion of classified wounds were venous leg ulcers (25.2%), followed by acute wounds (10.6%). Other wound aetiologies included diabetic foot ulcer, pressure ulcers, and several wounds that were "hard-to-heal wounds" or "unclassified." The median of total assessment period was 49 (IQR: 28 to 77) days. The primary objective of the study was an assessment of wound progression. However, levels of devitalised tissue (wound bed necrosis and fibrin were also assessed. Although baseline levels of necrosis was low (median of 0.0%, IQR: 0.0 to 0.0, range 0 to 100%) there was a significant reduction in mean wound area covered with necrosis from baseline was observed with an estimated mean change from baseline of -3.6% (95%CI: -5.6 to -1.6) at the first assessment visit, up to -8.6% (95%CI: -13.0 to -4.7) at the final assessment visit. Median fibrin wound bed deposits were 50.0% at baseline and, with treatment with HRWD™ levels of fibrin decreased and there was a significant reduction in percentage of wound area covered by fibrin over the course of the assessment period with a mean change from baseline of -29.3% (95%CI: -37.2 to -21.3).

Sterpione et al[50] reported on 86 patients with wounds of various aetiologies (including venous leg ulcers, diabetic foot ulcers, pressure ulcers, and acute wounds) requiring removal of devitalised tissue from the wound bed. Initial treatment included the application of HRWD™, and patients were monitored for up to 20 weeks. Devitalised tissue was present on the wound bed in 76.7% and 84.9% of cases, respectively. Application of the HRWD™ resulted in a decrease in the percentage of wounds with predominantly devitalised tissue (84.7% to 11.8%). The study concluded that the HRWD™ was effective in promoting wound cleansing and debridement, thus supporting good wound bed preparation.

Mikosiński et al[45] undertook a multicentre, prospective observational study that followed patients for 12 weeks or until complete wound closure with wound assessment every two weeks. Clinical endpoints for the study included the percentage wound coverage of necrosis or fibrin deposits on the wound surface. Percentage of necrotic tissue coverage of the wound surface at baseline was low (1.25%) but there was a steady decrease in levels of necrosis over the course of the assessment period (0.21% at week 8 and 0.34% at week 12). There was a high level of fibrin deposits at baseline (71.7%). Application of HRWD™ resulted in a sustained decrease in fibrin deposits at the final assessment (28.6% at week 8 and 23.3% at week 12).

An additional two case series were assessed.[31,51] All studies included the outcome of debridement. A total of nine patients were included in these additional studies with wound aetiologies including venous leg ulcer, diabetic foot ulcer, pressure ulcers, and hard-to-heal traumatic wounds). All studies reported a decrease in the level of devitalised tissue present on the wound surface.

The promotion of wound debridement and removal of devitalised tissue were discussed in five articles.[31,45,49-51] The reduction in devitalised tissue levels in the wound bed of the

Table 5. A summary of the included experimental studies evaluating HRWD

Reference	Study type	Dressing type	Main outcome measures	Main results
Eming et al, 2008[22]	Assessment of MMP activity in wound fluids taken from patients treated with dressing	HydroClean®	• Levels of MMP activity in wound fluid	• MMP activity inhibited • Direct binding of MMPs and binding of Ca^{2+} and Zn^{2+}
Rippon et al, 2018[52]	In vitro microbiology	HydroClean®, HydroClean® plus*	• Dispersal of biofilm	• Biofilms broken up and dispersed by HRWD™

* Evidence was only assessed relating to non-medicated HRWD™ and where evidence could be separated from PHMB-containing HRWD™

wounds was accompanied by a corresponding increase in the levels of granulation tissue present, and improvements in wound progression.

HRWD™ in infection control

The ability of non-medicated HRWD™ in infection control was discussed in three articles and related to the dressing's ability to absorb and sequester microorganisms and the clinical effects on clinical signs of infection.[49,50,52] Rippon et al[52] reported a laboratory study evaluating the efficacy of HRWD™ in aiding the absorption and sequestration of microorganisms known to reside (and cause infections) within the wound environment. As part of the evaluation, 24-hour *Staphylococcus aureus* and *Pseudomonas aeruginosa* biofilms were established in vitro and samples from several dressings (including HRWD™) was applied to the biofilm and incubated at 37°C for up to three days. The data showed that biofilms are broken up and dispersed by HRWD™. Incubation of biofilms for 24 hours with the non-medicated dressing (i.e., HRWD™ with no bound PHMB) resulted in a decrease in the number of bacteria recovered from *S. aureus* and *P. aeruginosa* biofilms compared with controls. The authors concluded that the dressing was effective at biofilm debridement in vitro and that the mechanism was physical in nature. The physical characteristics of the HRWD™ was responsible for the breakup and dispersal of the biofilm so that the resultant planktonic (free form) microorganisms were absorbed by the dressing, and subsequently retained (trapped) within the dressing.

Two observational studies provided supporting clinical evidence for the efficacy of the microbe-absorbing HRWD™ in reducing levels of infection.[49,50] Goedecke et al[49] presented results from an observational study assessing the efficacy of HRWD™ in a variety of wounds (Table 4). The study included 278 patients who each received treatment for a median of 49 days. Infection or "local signs of infection" were rated subjectively with clinicians giving an assessment of infection using a number of pre-defined states: 'redness,' 'oedema', 'odour', 'fragile granulation tissue', 'increased wound temperature', 'none' or 'other'. Clinicians noted a decrease in several signs of local infection over the assessment period: erythema decreased from 39.6% at baseline to 25.0%, oedema from 33.5% to 5.0%, wound odour from 11.5% to 5.0%, and fragile granulation tissue from 5.4% to 0.0%. The authors concluded that the use of HRWD™ has the potential to improve clinical outcomes in patients with acute and a variety of hard-to-heal wounds.

Sterpione et al[50] in an open-labelled non-comparative study on the efficacy of HRWD™ in 86 patients with wounds of varying aetiologies reported on a number of clinical outcomes as part of a coordinated wound dressing treatment regimen. During the study, patients were regularly monitored for up to 20 weeks (or less if the wounds had healed). Assessments were conducted at four, eight, 12 and 20 weeks. Wound progression was the primary outcome measurement but a number of secondary objectives, including the number of wounds showing clinical signs of infection, were also monitored. Clinicians assessed whether wounds were infected by examining the wound for signs of infection at the commencement and conclusion of the study. At the start of the study signs of infection were observed in 19.3% of wounds. The proportion of wounds infected decreased significantly over the course of the assessment period, decreasing to 3.6% of wounds exhibiting signs of infection at the final assessment visit ($p<0.01$). The study authors concluded that it was likely that the HRWD™'s ability to sequester and retain microorganisms played a role in reducing the level of infection in this study.

The absorption of microorganisms by non-medicated HRWD™ via the dressing's exudate management capacity, and the subsequent sequestration and "locking in" of the microbes offers an alternate approach of infection control. The dressing acts by a physical means to retain microorganisms within the dressing and are removed when the dressing is changed. Both the evidence from Rippon et al[52] showing a reduction in the number of microorganisms recovered in their laboratory studies, and the reduction in clinical signs of infection in clinical studies[49,50] using a wound dressing (HRWD™) containing no antiseptic or antimicrobial agent indicates an antimicrobial action by HRWD™.

Limitations

This study has the intrinsic limitations of a narrative review.[53] Some relevant articles may have been omitted because they were not captured in our review strategy or were not included because of the exclusion criteria (e.g., not available in full text or written in a language other than English). The findings of this review should be interpreted with caution as they were derived from seven articles including two pre-clinical studies.

Conclusions

Non-medicated HRWD™ was shown to have positive benefits on exudate management, particularly in the absorption and sequestration of damaging exudate components such as MMPs. The resultant decrease in excessive protease levels within the wound aids in rebalancing the wound environment regarding protease levels and promoting wound progression. HRWD™s promote autolytic debridement and the removal of devitalised tissue, which is a focus for microbial growth, and has been shown to result in a reduction in the clinical signs of infection in wounds. These results indicate that HRWD™, which contains no antiseptic or other antimicrobial agents, can have an antimicrobial effect in the absence of antimicrobials and may be used to treat infected wounds. Furthermore, this non-medicated wound dressing with antimicrobial effects is an ideal dressing for use as part of antimicrobial stewardship initiatives because of the dressing is unlikely to contribute to the emergence of antimicrobial resistance though its use. HRWD™ (HydroClean®) can be used as a wound dressing for promoting the goals of antimicrobial stewardship (AMS)[37] and can offer opportunities for clinical practice, educational,

and healthcare policy benefits provided by the adoption of AMS programmes.

Conflict of interest

This review was supported by Paul Hartmann AG, Germany. The sponsors had no involvement in the writing of this manuscript. The authors have no other conflicts of interest to declare.

Ethics statement

An ethics statement is not applicable.

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Author contribution

All authors contributed equally to writing and editing of the manuscript, approve the final submission and share responsibility for integrity of the work.

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