

Managing highly exuding wounds — removing the risk of infection



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Unmanaged exudate is a challenge facing clinicians worldwide. Exudate in chronic wounds contains proinflammatory cytokines, immune cells, proteases, and micro-organisms. In excess, these components cause tissue damage and create a suitable environment for bacterial growth potentially leading to infection, biofilm formation and persistent inflammation. In an international webinar broadcast on 23 July 2020 and available to watch on demand on [Wounds International TV](#), Catherine Milne, Dr Helen Thomason and Maria Hughes examined the negative impacts of unmanaged excessive exudate on healing, particularly the increased risk of infection associated with bacteria and excess matrix metalloproteinases (MMPs). They outlined how to select the most appropriate super-absorbent dressing, and how KERRAMAX CARE™ Super-Absorbent Dressing (3M+KCI) fits in the practical management of highly exuding wounds.

Exudate is the body's normal physiological response to cellular injury. Mediators and enzymes released upon injury cause vasodilation and increased capillary permeability, resulting in increased interstitial fluid and local inflammation, reducing the risk of infection and supporting cell proliferation. As healing occurs, the amount of exudate decreases.

However, as in the case of chronic wounds, exudate can delay healing, negatively impact patient quality of life and increase socioeconomic burden when the amount is

excessive or insufficient, its composition is abnormal and/or the exudate is in the wrong place (Moore and Strapp, 2015; World Union of Wound Healing Societies [WUWHS], 2019). Moisture levels need to be balanced to enable moist wound healing and prevent maceration. The components of exudate differ in acute versus chronic wounds, see [Table 1](#). In chronic wounds, high levels of enzymes such as MMPs and elastase break down proteins and extracellular matrix, stalling healing and damaging healthy tissue. This damage supports the growth of

Table 1. Exudate in acute versus chronic wounds (adapted from WUWHS, 2019).

Exudate component	Comment	Acute wound level	Chronic wound level
Proinflammatory cytokines	Small proteins involved in cell signalling and inflammatory response	Low	High (stimulating protease production)
Immune cells, e.g. lymphocytes and macrophages	Immune defence, growth factor production	Moderate	High
Proteases (protein-degrading enzymes)	Degradation of proteins, assisting in autolysis and cell migration, scar remodelling	Moderate	High (degrading growth factors, hindering cellular proliferation and migration, disrupting newly-formed extracellular matrix)
Protease inhibitors	Moderate protease action, preventing tissue breakdown	Low to moderate	Moderate to high
Proteins, e.g. albumin, fibrinogen, globulins	Transport of other molecules, anti-inflammatory effects, blood clotting, immune functions	High	Low
Growth factors	Stimulate cellular growth	High	Low
Micro-organisms	Always present; restrict oxygen at the wound bed	Low	Moderate to high (bioburden)
Mitogenic activity	Stimulate fibroblast proliferation	High	Low

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microbes harboured within the exudate, increasing infection risk and reducing oxygen availability for cellular function (Swezey, 2015).

THE IMPORTANCE OF MANAGING EXCESS EXUDATE

Any factor increasing the amount of interstitial fluid within wound tissues will increase the volume of wound exudate (WUWHS, 2019). Excess exudate is a symptom of underlying conditions or comorbidities. Common causes include excessive or uncontrolled inflammation, bioburden, inadequate protein stores and uncontrolled conditions, such as lymphoedema, venous insufficiency or congestive heart failure (Schultz et al, 2011; Percival, 2017; WUWHS, 2019), see *Box 1*.

Excessive exudate increases the risk of infection, so it is important to act preventatively when treating highly exuding, non-infected

Box 1. Conditions associated with high exudate production (Schultz et al, 2011; Percival, 2017; WUWHS, 2019).

- Congestive cardiac, renal or hepatic failure
- Infection/inflammation
- Endocrine disease
- Systemic medication: calcium-channel blockers, non-steroidal anti-inflammatory drugs, steroids, glitazones, ACE inhibitors
- Obesity
- Fluid overload during intravenous therapy
- Malnutrition
- Advanced age
- Low serum albumin levels
- Elevated C-reactive protein levels.

wounds. These wounds should be appropriately managed so harmful components within exudate (micro-organisms and MMPs) are locked away within topical dressings, helping to reduce the risk of infection. The negative effects of excessive, unmanaged exudate may vary according to wound type as described in *Table 2*.

CONSIDERATIONS WHEN SELECTING DRESSINGS FOR HIGHLY EXUDING WOUNDS

The clinician needs to understand the clinical issues that can arise from high exudate levels and how it increases the complexity of wound management [*Figure 1*]. Clinicians also need to ensure the exudate management strategy matches the patient's needs following holistic wound assessment. Frequency of dressing change depends on a number of patient and wound factors, such as comorbidities, and wound aetiology, duration and location. Dressing changes are also based on external factors such as availability of dressing modalities and sizes.

Figure 2 illustrates the results of poor wound management when an inappropriate dressing is selected to manage excessive exudate levels.

When selecting an appropriate dressing, clinicians should consider wound position, what could come into contact with the wound (particularly if in a weight-bearing area), ambient temperature/humidity, patient adherence to therapy, pain, previous dressing regimen or intervention and other environmental issues, such as compatibility with other therapies including compression (WUWHS, 2019).

There is no internationally accepted standard method for measuring rate of exudate

Table 2. Negative effects of poor exudate management on wounds.

Wound type	Impact of poor exudate management
General	Leakage and soiling, malodour, increased risk of infection, frequent dressing changes, discomfort and pain, periwound skin damage, wound expansion, psychosocial effects (WUWHS, 2019)
Impact associated with, but not limited to, specific wound types	
Diabetic foot ulcer	Periwound maceration, reduction in shear stress tolerance and reduced healing contribute to amputation risk (Armstrong et al, 2017)
Pressure ulcer	Macerated wound edges prevent cell signalling needed for proliferation and healthy keratinocyte migration (Anthony et al, 2019)
Venous leg ulcer	Cytokine-rich exudate disrupts the skin barrier and dermal integrity, increasing wound size, pain and healing times (Xie et al, 2018)
Surgical wound	Prolonged healing time, patient discomfort, potential for rehospitalisation (Sandy-Hodgetts, 2019)
Skin tear	Prolonged healing time, more frequent dressing changes increasing the risk of medical adhesive-related skin injury (LeBlanc et al, 2018)
Atypical wound	Odour, pain, discomfort, potential for wound deterioration (Isoherranen et al, 2019)

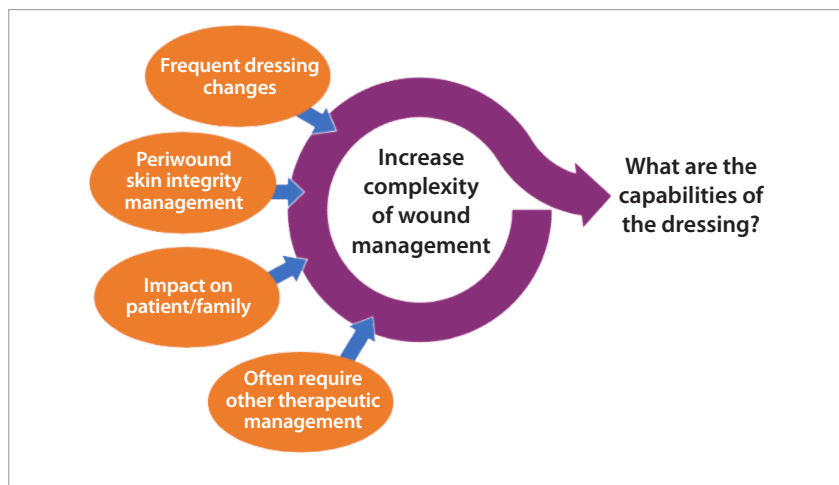


Figure 1. Clinical issues associated with excessive exudate levels.

production, but laboratory research has identified typical exudate production rates for different wound types, see [Table 3](#). However, these may be underestimated as they do not allow for evaporation of fluid from the dressing surface or take into account the causes of higher exudate levels.

There are a variety of options available for managing highly exuding wounds, including super-absorbent dressings, foam dressings and gelling fibre dressings. The mode of action needs to be considered when selecting a dressing, as each dressing type has different properties with respect to absorption, retention of exudate under compression and sequestration of bacteria and MMPs. Matching these characteristics to the wound's exudate profile is important when trying to establish and maintain a moist wound environment (Bishop et al, 2003). In the case of high levels of exudate, super-absorbent dressings may be favourable

Table 3. 'Typical' exudate production rates (adapted from WUWHs, 2019).

Wound type	Rate of exudate production (g/cm ² /day)
Leg ulcer	0.17–0.21
Granulating wound	0.51
Skin donor site	0.42
Partial-thickness burn	0.42–0.86
Full-thickness burn	0.34

over foam and gelling fibre dressings.

SUPER-ABSORBENT DRESSINGS

Super-absorbent dressings contain polyacrylate polymers, which have the ability to swell to many times their original size and weight, holding large volumes of fluid while maintaining their structure (Dhodapkar et al, 2009). This makes super-absorbent dressings ideal for highly exuding wounds (Ousey et al, 2013).

The ideal super-absorbent dressing should possess the following qualities (Barrett, 2015):

- Absorb and retain high levels of exudate even under compression
- Fast horizontal and vertical wicking
- Minimise periwound contact with exudate
- Sequester and retain bacteria, removing them from the wound environment
- Sequester and retain MMPs to prevent tissue damage
- Conform to the wound bed
- Atraumatic at removal
- Painless and comfortable to wear
- Cost-effective.

Figure 2 | Implications of inappropriate dressing selection (images courtesy of Maria Hughes).

Exudate was pooling down the leg causing painful maceration and excoriation to the patient's skin (2A). The dressing was required to be changed twice daily due to inappropriate dressing selection. The non-adherent primary dressing adhered to the wound bed (2B); the secondary dressing was too small and not

absorbent enough to manage the amount of exudate (2C). In addition, the underlying cause of venous disease was not being addressed resulting in more pain for the patient and more visits for the nursing staff.



KERRAMAX CARE™ SUPER-ABSORBENT DRESSING

KERRAMAX CARE™ Super-Absorbent Dressing (3M+KCI) is a dressing for moderate to highly exuding wounds designed to provide high fluid absorption and retention. The dressing can be used as a primary or secondary dressing, be applied using either side and is conformable to body contours. It consists of four components [Figure 3]:

- Soft, non-woven outer layer for patient comfort
- Unique horizontal wicking layer that helps utilise the full absorption capacity of the dressing reducing the risk of gel blocking (Rose, 2015)
- Super-absorbent core with EXU-SAFE™ Technology that sequesters and retains exudate, MMPs and bacteria (Singh and Thomason, 2020)
- Heat-sealed border to prevent exudate leakage, reducing periwound maceration risk.



Figure 3. KERRAMAX CARE™ Super-Absorbent Dressing.

HOW DOES KERRAMAX CARE™ DRESSING ADDRESS THE REQUIREMENTS OF AN IDEAL SUPER-ABSORBENT DRESSING?

Absorption and retention of exudate

The total amount of fluid a dressing can absorb can be measured by its free swell capacity. A free

swell capacity test of several commercially available super-absorbent dressings demonstrated that all handled a large volume of fluid (>130 g per 100 cm²) (McIntyre, 2019). However, work completed by Helen Thomason and colleagues at the University of Manchester in June 2020 found that the fluid retention properties of these dressings varied greatly [Figure 4]. At 40 mmHg, KERRAMAX CARE™ Dressing and Vliwasorb® Pro (L&R Medical) released 18% and 14% of the fluid they had absorbed respectively, while Zetuvit® Plus (Paul Hartmann AG) released 33% of its fluid content. Thus, KERRAMAX CARE™ Dressing and Vliwasorb® Pro exhibited the greatest retention properties.

Sequestration and retention of bacteria

To test the ability of different dressings to sequester *Staphylococcus aureus* and *Pseudomonas aeruginosa*, 10 ml of each bacterial culture was applied to dressings every day for a week to mimic a moderately exuding wound (Singh and Thomason, 2020). After days 1, 3 and 7, bacteria not retained within the dressing's inner core were visualised by incubating on agar plates; in other words, bacteria not retained in the dressing could be seen as growth on the agar. Only KERRAMAX CARE™ Dressings retained *P. aeruginosa* within its inner core on days 1, 3 and 7. Zetuvit® Plus retained *P. aeruginosa* within the dressing's inner core on days 1 and 3 but gauze, Kliniderm® (H&R Healthcare), Vliwasorb® Pro, Mextra® (Mölnlycke Healthcare) and ConvaMax™ (ConvaTec) released bacteria after just one application of bacterial culture. The results of these studies were similar for KERRAMAX CARE™ Dressings retaining *S. aureus* (Singh and Thomason, 2020) and methicillin-resistant *S. aureus* (Thomas and Westgate, 2015) at days 1, 3 and 7.

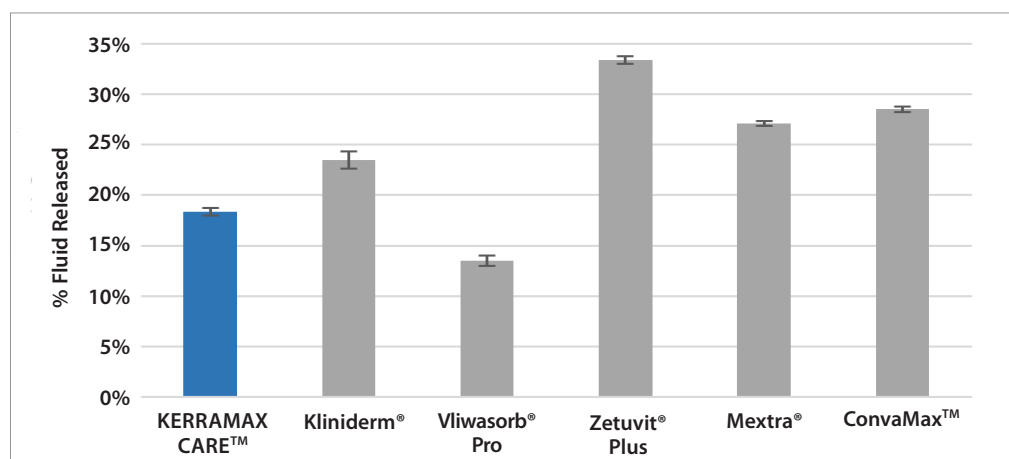


Figure 4. Percentage of fluid released by superabsorbent dressings under 40 mmHg.

WHAT IS HAPPENING TO THE BACTERIA INSIDE THE SUPER-ABSORBENT DRESSING?

To determine whether the bacteria were locked within the inner core of each of the dressings, the sequestration experiment was repeated (Singh and Thomason, 2020). This time, a sample of each dressing was placed in excess media and disrupted in an attempt to release the bacteria from the inner core. The number of bacteria released from the dressing into the media was quantified using standard plate counts. All of the super-absorbent dressings retained a significant amount of *S. aureus* absorbed after one bacterial application (Singh and Thomason, 2020). However, after 3 days, some dressings retained less bacteria. After 7 days, KERRAMAX CARE™ Dressings retained between 680,000 and 18.8 million more bacteria than the other tested dressings [Figure 5]. It was also the only dressing to retain as much bacteria as it had on day 1.

WHERE DO THE BACTERIA RESIDE WITHIN THE SUPER-ABSORBENT DRESSING?

With respect to absorption and retention properties of a super-absorbent dressing, exudate components should be locked in the inner core and not remain on the wound contact layer, which could increase the risk of infection. To test this dressing capability, scanning electron microscopy was performed to visualise *P. aeruginosa* on the wound contact layer of KERRAMAX CARE™ Dressing versus another super-absorbent dressing after 7 days of bacterial application. Whereas no bacteria were detected on the wound contact

layer of KERRAMAX CARE™ Dressing, bacteria were detected on the wound contact layer of Kliniderm®, see Figure 6 (Singh and Thomason, 2020).

In the clinical setting, real-time visualisation of bacterial fluorescence of the wound bed in 10 highly exuding wounds showed KERRAMAX CARE™ Dressing sequestered exudate containing fluorescing bacteria with positive impacts on the wound bed (Milne, 2020). KERRAMAX CARE™ Dressings did not demonstrate leakage or strikethrough that would indicate bacterial transfer returning to the wound, its surrounding skin or into the patient's environment.

SEQUESTRATION AND RETENTION OF MMPs

Super-absorbent dressings with proven MMP binding properties may help to prevent tissue damage (Ousey et al, 2013; Wiegand and Hipler, 2013). The MMP-handling abilities of the super-absorbent dressings used in the previous experiments have also been studied (Singh and Thomason, 2020). All dressings retained almost 100% of MMP-2. This was also the case for MMP-9, with the exception of ConvaMax and gauze, which only retained 61% and 62%, respectively, of the quantity of MMP-9 applied (Singh and Thomason, 2020).

CLINICAL APPLICATION AND BENEFITS OF KERRAMAX CARE™ DRESSING

A large-scale evaluation study was performed in the community setting to evaluate patient safety, patient experience and ability of KERRAMAX CARE™ Dressing to manage highly exuding wounds (Hughes and Jones, 2017). The dressing was used in the management of 101 moderate to highly exuding wounds of various aetiologies. Reduced maceration, decreased exudate levels and improvements to wound healing were the primary clinical benefits identified by clinicians following the application of this dressing.

Almost all clinicians (98%) were happy to continue using KERRAMAX CARE™ Dressing as their super-absorbent dressing of choice, with 32% indicating the dressing had exceeded their expectations. Patient comfort, high fluid absorption, patient concordance and reduced number of district nurse visits were given as reasons for the use of KERRAMAX CARE™ Dressing. Patients found the dressing comfortable and convenient. The results of this study suggest KERRAMAX CARE™ Dressing is a

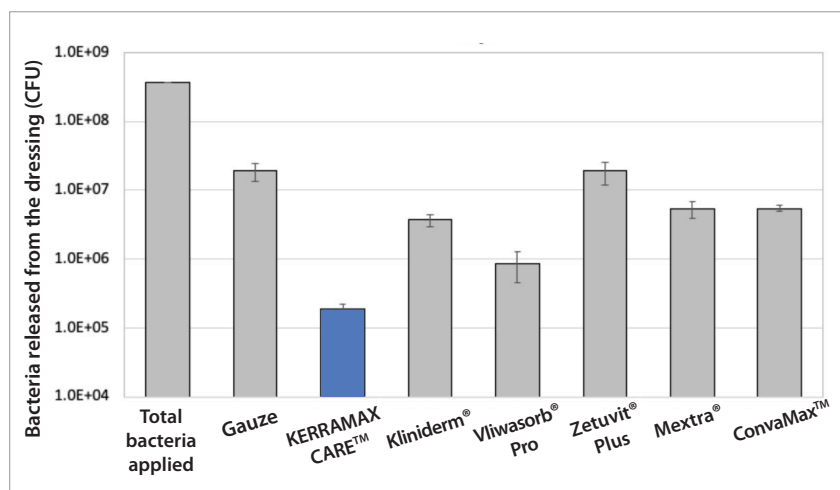


Figure 5. *S. aureus* released from super-absorbent dressings after 7 days (Singh and Thomason, 2020).

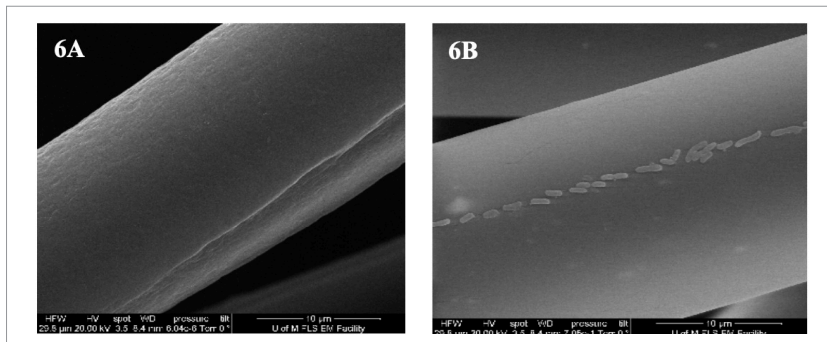


Figure 6. Scanning electron microscope images of the outer contact layer of (A) KERRAMAX CARE™ Dressing and (B) Kliniderm® showing where the bacteria resides in the dressing (Singh and Thomason, 2020)

useful addition to the district nurse's toolbox (Hughes and Jones, 2017). Examples from this study where KERRAMAX CARE™ Dressings have been successfully used on wounds at risk of infection as a result of excessive exudate are given in *Case studies 1 and 2*.

CONCLUSION

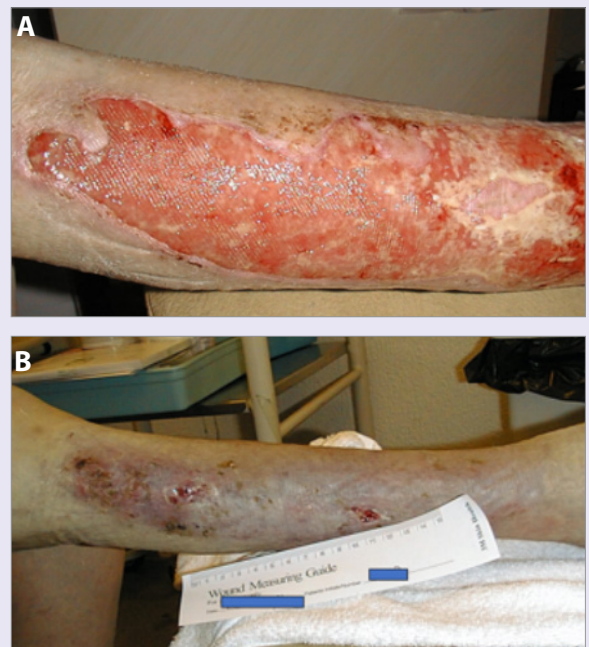
If excessive exudate is not properly managed it can lead to periwound maceration, prolonged healing times and an increased risk of infection. A dressing that can help to reduce potential damage caused by fluid, exudate, bacteria and MMPs is recommended for moderate to highly exuding wounds.

Case study 1 | Highly exuding venous leg ulcer at risk of infection.

An 86-year-old female with a history of anaemia and hypertension sustained trauma to the lateral aspect of her right leg (A) resulting in oedema and excess exudate. A leg ulcer assessment and an ankle-brachial pressure index (ABPI) were performed.

The wound was managed with a silicone sheet and an absorbent pad with a standard bandage applied, which required daily dressing changes. There was clear evidence of venous disease and oedema, suggesting the underlying cause was not being addressed. Following the initiation of KERRAMAX CARE™ Dressing and compression with Coban™ 2 Two-Layer Compression System, the frequency of dressing change reduced to twice weekly.

KERRAMAX CARE™ Dressings were used for 2 weeks managing the excess exudate and assisting with wound healing. After this period, treatment continued with a foam dressing and a compression hosiery kit to healing at 12 weeks (B).

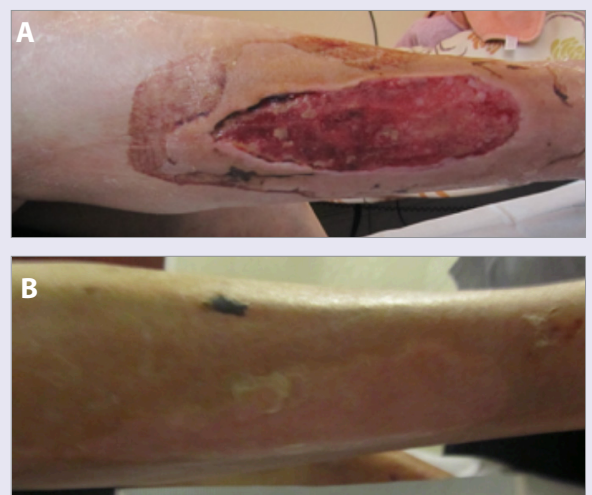


Case study 2 | Trauma wound at risk of infection.

An 88-year-old female presented in A&E after sustaining a traumatic injury from her wheelchair. No active treatment was administered in A&E. She was treated in the community where she underwent a leg ulcer assessment including an ABPI and conservative sharp debridement (A).

The wound was highly exuding, the periwound skin was macerated and there was a high risk of infection.

KERRAMAX CARE™ Dressing was applied under compression for several weeks, after which her wound was managed with a primary wound contact layer dressing (N-A™ Ultra Dressing, 3M+KCI) and Coban™ 2 Two-Layer Compression System (3M+KCI). KERRAMAX CARE™ Dressing locked in the exudate, preventing it from contacting the skin, reducing maceration and excoriation. The wound healed after 10 weeks (B) and the patient continued to apply emollients to soothe and hydrate the skin.



KERRAMAX CARE™ Dressings, when compared with other available super-absorbent dressings *in vitro*, have demonstrated comparable ability to sequester and retain bacteria within the inner core (Singh and Thomason, 2020) and away from the wound bed, thereby reducing potential infection risk. This is supported by real-world results that show KERRAMAX CARE™ Dressing absorbs, retains and sequesters fluorescing bacteria in the clinical setting for highly exuding wounds (Milne, 2020).

Real-world data has also shown that KERRAMAX CARE™ Dressings can enhance care by improving patient comfort and reducing the frequency of dressing changes, leading to decreased nursing time and patient distress (Hughes and Jones, 2017). KERRAMAX CARE™ Dressings are a beneficial advanced wound care option for the management of moderate to highly exuding wounds.

REFERENCES

- Anthony D, Alosoumi D, Safari R (2019) Prevalence of pressure ulcers in long-term care: a global review. *J Wound Care* 28(11): 702–9
- Armstrong DG, Boulton AJ, Bus SA (2017). Diabetic Foot Ulcers and Their Recurrence. *New Eng J Med* 376(24): 2367–75
- Barrett S (2015) Cost-effective management of wound exudate. *Wound Essentials* 10(1): 66–73
- Bishop SM, Walker M, Rogers AA, Chen WYJ (2003) Moisture balance: optimising the wound dressing interface. *J Wound Care* 12: 125–8
- Dhodapkar R, Borde P, Nandy T (2009) Superabsorbent polymers in environmental rediation. *Global NEST J* 11(2): 223–3
- Hughes MA, Jones J (2017) A large-scale evaluation of managing moderate and highly exuding wounds in the community. *Wounds UK* 13(3): 78–83
- Isoherranen K, Jordan O'Brien J, Barker J et al (2019). EWMA document; Atypical wounds. Best clinical practice and challenges.
- LeBlanc K et al (2018) *Best practice recommendations for the prevention and management of skin tears in aged skin*. Wounds International 2018. Available to download from www.woundsinternational.com
- McIntyre W (2019) *Absorbency, retention under compression, and absorbency under compression testing of KERRAMAX CARE™ against market competitors - R&D Trial Report CHC R821*. Crawford Healthcare, Knutsford, UK
- Milne C (2020) *Superabsorbent Dressing Impact on Fluorescing Bacteria in the Real-World Setting*. Poster presented at: WOCNext 2020 Reimagined, June 7–10, 2020
- Moore Z, Strapp H (2015) Managing the problem of excess exudate. *Br J Nurs* 24(15): S12–7
- Ousey K, Atkin L, White R (2013) Superabsorbent wound dressings: A literature review. *Wounds UK* 9(3): 52–60
- Percival SL (2017) Importance of biofilm formation in surgical infection. *Br J Surg* 104: e85–94
- Rose R (2015) *A large clinical evaluation assessing the tolerance & effectiveness of super-absorbent dressing, KERRAMAX CARE*. Poster presented at: Wounds UK, Harrogate, November 9–11. Available at: <https://epostersonline.com/wnds2015/node/154?view=true> (accessed 31.07.20)
- Sandy-Hodgetts K (2019) Surgical wound complications: a 21st century problem? *J Wound Care* 28(10): 645
- Schultz GS, Davidson JM, Kirsner RS et al (2011) Dynamic reciprocity in the wound environment. *Wound Rep Reg* 19(2): 134–48
- Singh G, Thomason H (2020) *Sequestration and retention of bacteria by super-absorbent dressings over time. KCI CHC R1043 (in vitro)*. University of Manchester & KCI Knutsford, UK
- Swezey L (2015) *The difference between acute and chronic wounds*. Wound Source. Available at: www.woundsource.com/blog/difference-between-acute-and-chronic-wounds (accessed 7.06.20)
- Thomas H, Westgate SJ (2015) *An in vitro comparison of MRSA and P. aeruginosa sequestration by five super-absorbent wound dressings*. Poster presented at: Wounds UK Annual Conference; November 9–11, 2015; Harrogate, UK
- Wiegand C, Hipler UC (2013) *In vitro evaluation of MMP binding capacity of a super-absorbent dressing and the reduction of collagenase activity*. Poster presented at: Congress of European Wound Management Association (EWMA); May 15–17, 2013; Copenhagen, Denmark
- World Union of Wound Healing Societies (2019) *Consensus document. Wound exudate: effective assessment and management*. London, Wounds International
- Xie T, Ye J, Rerkasem K, Mani R (2018) The venous ulcer continues to be a clinical challenge: an update. *Burns Trauma* 6:18

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