Superabsorbent wound dressings: A literature review

KEY WORDS
- Dressing
- Literature review
- Microbiology
- Superabsorbent
- Wound

Superabsorbent dressings are promoted for use on moderate to highly exudating wounds to absorb and retain fluid, thus reducing the risk of leakage and minimising the risk of maceration. The fluid handling capacity of these dressings varies depending on the design and construction, not all should, therefore be regarded as equivalent. This article provides an overview of the literature relating to superabsorbent dressings discussing the evidence base for their use. Twenty-nine articles were identified as relevant to the review; no relevant randomised controlled trials were located. There were no restrictions placed on literature search dates. The only exclusion criteria was articles not written in English.

KAREN OUSEY
Reader, School of Human and Health Sciences, Centre for Health and Social Care Research, University of Huddersfield, Huddersfield

LEANNE ATKIN
Lecturer/Practitioner, School of Human and Health Sciences, Centre for Health and Social Care Research, University of Huddersfield, Huddersfield

RICHARD WHITE
Professor of Tissue Viability, Institute of Health and Society, University of Worcester, Worcester

Highly exuding wounds can affect people of all ages with the inappropriate management of exudate leading to skin damage, pain, and reduced patient wellbeing (Wounds UK, 2013a). Effective exudate management can reduce time to healing, reduce dressing change frequency, and nurse input, thereby optimising healthcare efficiency.

Superabsorbent dressings are designed to absorb and retain exudate. Products in this category include: Flivasorb® (Activa Healthcare; Flivasorb is known as Vliwasorb® [Lohmann and Rauscher] in Europe); Ecylpse® (Advancis Medical); KerraMax™ (Crawford); sorbion sachet extra (sorbion); Mextra® (Mölnlycke Health Care); and DryMax® Extra (Aspen).

This article provides an overview of the literature relating to superabsorbent dressings discussing the evidence base for their use and offering criteria for dressing selection.

WHAT ARE SUPERABSORBENT DRESSINGS?

The new generation of superabsorbent dressings contain polyacryate polymers (SAPs); these have hydroactive properties as a result of their high density ionic charge (Pytlik et al, 2005). They 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).

Superabsorbent polymers have been used since the 1980s and are commonly found in nappies, incontinence products, and feminine hygiene products. In recent years, there has been a considerable increase in the number of wound dressings that contain SAPs, (Cutting and Westgate, 2012). However, the mere presence of SAPs does not guarantee optimal wound dressing performance; the fluid handling capacity of these dressings varies substantially, depending on the design and construction of the polymer, which may or may not be combined with other components to influence fluid handling (Cutting and Westgate, 2012).

SAPs are indicated for moderate to highly exuding wounds. They are designed to absorb and retain fluid, and so reduce the risk of leakage and maceration (Wiegand and White, 2013). Their substantial absorption capacity allows extended wear time, this reducing the frequency of dressing changes and the number of times the wound is disturbed, while still protecting the surrounding skin (Stephen-Haynes, 2011).

Additionally, SAPs have been shown to have other properties that enhance wound healing. These include:
- Bioburden reduction *in vitro* (Wiegand et al, 2013).
- Protease modulation *in vitro*, including reducing metalloproteinase (MMPs; specifically -2 and -9) and bacterial collagenase activity (Wiegand and White, 2013; Wiegand and Hipler, 2013).
- Binding of elastase and antioxidant potential (Wiegand et al, 2011).

LITERATURE REVIEW

To establish the evidence for the use of SAPs, a literature search was undertaken to generate a comprehensive list of publications relating to their use. Every attempt was made to ensure that the process of identifying studies was complete and unbiased. This article was not designed to be a systematic review, but rather to provide a summary of all published information in this area, with discussion and critical appraisal where appropriate.

"All databases were searched from their date of creation to 1 July 2013. Results were not restricted to recent years to ensure that all published studies were included."

The following electronic databases were searched: CINHAL, the Cochrane Central Register of Controlled Trials, the Cochrane Database of Systematic Reviews, the Database of Abstracts of Reviews of Effects, Health Technology Assessments and National Health Service Economic Evaluation, Embase, Ovid MEDLINE, PubMed, and Wounds UK. All databases were searched from their date of creation to 1 July 2013. Results were not restricted to recent years to ensure that all published studies were included. Reference lists from primary and review articles retrieved from the database searches were hand-screened to ensure no relevant articles were missed. Articles not written in English, and posters, were excluded.

The authors (RW, KO, LA) read all located articles and agreed all were to be included in the review.

Search terms

Search terms used were: SAP$; superabsorbent polymers; supra absorbent polymers; superabsorbent$ dressings; superabsorbent$ dressings; super-absorbent$ dressings; supra absorbent$ dressings; supra-absorbent$ dressings; hydration response technology (please note that the "$" symbol allows the search engine to retrieve content with all ending [i.e. wound, wounds, wound*ed*, wound*ing*, etc]).

REVIEW RESULTS

In total, 29 articles were accepted for inclusion. None were randomised controlled trials.

Clinical performance

sorbion sachet extra

A convenience sample of 53 patients recruited over 12 months from 12 hospital or community-based wound clinics was used for Cutting's (2009) 5-week evaluation. All participants had either moderately or heavily exuding wounds. Wound types included: venous leg ulcers, pressure ulcers, diabetic foot ulcers, dehisced abdominal wounds, and vein graft donor site wounds. At baseline, 42 wounds were recorded as producing high, and 11 moderate, levels of exudate. The majority (*n*=36) of the wounds were over 12 weeks' duration. Of the 42 wounds with high exudate levels at baseline, five had no exudate, six had light, nine had moderate, and 22 had high levels of exudate at week 4. Of the 11 wounds with moderate exudate levels at baseline, three were rated as having no exudate, two as light, five as moderate, and one high at week 4. The author reported that seven wounds increased in area by week 4, due to extensive comorbidities, general deterioration of the patient, patient death, and a reduction in dressing changes for unknown reasons (Cutting, 2009).

In a health economics study using data acquired from the THIN database, Panca et al (2013) matched 100 randomised venous leg ulcer patients treated with either AQUACEL® (ConvaTec), DryMax, Flivasorb, KerraMax, or sorbion sachet extra. The only clinical outcome of note was in the percentage change in wound area of unhealed wounds where AQUACEL-treated wounds increased by 43%, while other unhealed wounds decreased by 20%–53% (*P*=0.001).

Flivasorb

Tadej (2009) described a single patient case study evaluating the use of Flivasorb in a patient with a highly exuding venous leg ulceration and concluded that Flivasorb enabled less frequent dressing change and reduced the risk of maceration leading to improvements in patient quality of life.

Faucher et al (2012) conducted a multicentre, prospective, noncomparative observational study to evaluate the clinical efficacy and absorbency capacity of Flivasorb. Fifteen patients with copiously exuding wounds of any aetiology were recruited. These included inpatients and outpatients. The majority (*n*=8) had chronic wounds (53%), two had pressure ulcers (13%), and one (7%) had venous ulceration, three (20%) had ulcerating tumours. SAPs were used as a primary dressing in six cases (40%). The remaining patients had cavity wounds where a wound filler (e.g. an alginate) was required, with the SAP used as a secondary dressing.

On presentation, 13 of the 15 patients reported problems with moderate to high exudate levels resulting in compromised surrounding skin condition; only two patients had healthy peri-wound skin. The surrounding skin condition was believed to be affecting the patients pain levels, with eight patients (53%) reporting moderate pain at dressings change.

After 7 days use of a SAP, improvements in the condition of the surrounding skin were reported. Eleven patients (73%) were reported as having healthy peri-wound skin. In the remaining cases, maceration

"Lloyd-Jones (2011) evaluated Eclypse® (Advancis Medical) as a primary and secondary dressing on a sample of ten patients. Results acknowledged the dressing managed exudate well, with dressing changes being reduced to 3–4 days, rather than daily."

of the surrounding skin improved, reducing from seven patients (46.7%) to only one (6.7%) in the same time period. In addition, they reported elimination of pain on dressing change due to improvements in surrounding skin. There was a reduction in dressing change frequency from daily to twice a week in 12 (80%) cases following 3 days' use of Flivasorb. The authors concluded that their results indicate effective fluid handling of exudate, reduction in peri-wound maceration and improvements in wound bed condition (Faucher et al, 2012).

Nineteen patients with heavily exuding wounds who required dressing change three to seven times weekly consented to evaluate Flivasorb (Verrall et al, 2010). The sample consisted of a range of wound types: 16 established venous leg ulcers, one pressure ulcer, one arterial ulcer, and one chest wound. Results of the evaluation stated that nurses found Flivasorb did not adhere to the wound and reduced dressing changes by an average of one to two visits per week. The authors state that dressing changes were reduced in 100% of the cases, with the average dressing change being 3.2 compared to 1.8 when Flivasorb was used.

DryMax Extra

Stephen-Haynes (2011) published a literature review of DryMax and three short case studies illustrating that DryMax retained and absorbed exudate. A further study (Stephen-Haynes and Stephens, 2012) in primary care involved 40 patients with wounds of various aetiologies and differing exudate types.

Hindhede and Meuleneire (2012) presented a case series of 30 patients with acute and chronic wounds of various aetiologies, evaluating the capacity of DryMax Extra to manage excessive exudate. Eighteen of the patients had severely exuding wounds, nine had fairly large amounts of exudate, and three had moderately exuding wounds. Dressings were changed from a daily to once a week basis, based on the clinician's judgment and the needs of the individual patient.

The authors report that as the exudate levels decreased, so did pain levels. They reported one patient who required skin protection during the use of DryMax and one who reported pain due to the superabsorbent on removal. However, they state that when the dressing was moistened with a saline solution, the pain reduced. Their overall evaluation of the product was that it protected the wound borders from maceration, oedema, and erythema (Hindhede and Meuleneire, 2012).

Sixteen patients from four leg ulcer clinics were included in an evaluation of DryMax (Allymamod, 2011): twelve patients had chronic venous leg ulcers, one a deep dermal burn on the lower limb that had failed to heal after 6 weeks, and one a category 3 pressure ulcer on the heel. At the end of the first weeks' evaluation, there was a marked improvement in both the wound bed and peri-wound skin with no reports of malodour. By the second week, patients required 15 fewer dressing changes, and by week four there were 44 fewer dressing changes. The author concluded that the use of DryMax had reduced clinic attendance, reduced costs in travel and inconvenience for the patients, thereby improving quality of life for this patient group.

Eclypse

Eclypse was clinically evaluated by Godar and Guy (2010) in four case studies. They identified patients suffering from highly exuding venous leg ulceration that resulted in more frequent dressing changes, due to strike through and subsequent problems with peri-wound skin. In all four cases they found clinical benefits using Eclypse dressings, reporting improvements with condition of surrounding skin, reduction in need for dressing changes, and reduction in wound size.

Lloyd-Jones (2011) evaluated Eclypse as a primary and secondary dressing on a sample of ten patients. Results acknowledged the dressing managed exudate well, with dressing changes being reduced to 3–4 days, rather than daily, and that the continence status of patients did not affect the wear time of sacral dressings. All patients reported that the dressings were comfortable, and also achieved a reduction in pain during dressing change and continuous pain.

In two of the ten cases, Eclypse had been used as a secondary dressing, prior to Eclypse surgical pads had been used. Following the change of dressing regimen, dressing changes were reduced from 4 times daily to once every 2–3 days. Reported pain scores decreased from 10 to 9 immediately, with a further reduction to 5 after 1 week.

Eclypse is also available in "boot" form, where it has been used successfully in the management of cellulitis (Rafter, 2011).

"An evaluation of four super-absorbent dressings … showed that sub-bandage pressures altered following expansion of the dressing under compression therapy, with Eclypse having the smallest effect (a 2.5% pressure increase)."

KerraMax

Hampton et al (2011) published a single patient case study using honey dressings in combination with KerraMax. They describe a 102-year-old patient with a long history of venous ulceration complicated by arterial disease (ankle–brachial pressure index, 0.7). The ulcer was highly exuding with evidence of colonisation by a *Pseudomonas* spp., but the authors do not report if the wound was infected or the levels of Pseudomonas. After 1 month of treatment, a reduction in wound pain and exudate level, improvement in condition of the wound bed and of surrounding skin, and also general improvements in the patient's quality of life were reported.

Mextra

This is the most recent product to become available on the UK market. So far, the only available published evidence is that of MMP binding *in vitro* (Wiegand and Hipler, 2013).

Alteration to sub-bandage pressures

As might be anticipated, the swelling of an absorbent dressing in a confined space (i.e. between compression bandage and wound) is likely to increase local pressure. Accordingly, an evaluation of four SAPs (Flivasorb, sorbion sachet extra, KerraMax, Eclypse) was undertaken by Cook (2011) to investigate if these dressings altered sub-bandage pressures when polymers in the dressing expanded.

Results showed that sub-bandage pressures altered following expansion of the superabsorbent dressing under compression therapy, with Eclypse having the smallest effect (a 2.5% pressure increase), and Flivasorb increasing sub-bandage pressure by 38% when used under 4-layer compression bandaging. Similar increases were seen when using 2-layer compression systems, ranging from a 0% increase with Eclypse to 24% with Flivasorb. It is worth noting that this was a small evaluation and lacked depth, rigour, and validity. However, it does identify that an alteration of sub-bandage pressure in this range of products deserves consideration as it may lead to detrimental effects on ulcer healing, patient comfort, and compliance with compression therapy (Cook, 2011).

Evidence for antimicrobial activity

The capacity of any wound dressing to reduce bioburden will depend on a number of factors related to composition and mode of action. Dressings may be impregnated with antimicrobial compounds, or have the capacity to sequester microorganisms (i.e. to adsorb them onto the surface, such that they are removed when dressings are changed).

When considering any *in vivo* action of SAPs, it is important to consider all possible modes of action. Where an antimicrobial compound is included in the formulation (e.g. polyhexamethylene biguanide [PHMB] has been used in one SAP), the antimicrobial effect will depend on the concentration and bioavailability of that agent.

For non-medicated SAPs, it has been claimed that the capacity of a dressing to absorb and retain (i.e. sequester) bacteria is an important function, particularly in chronic wounds (Wysocki, 2002). *In vitro* and animal *in vivo* microbiological studies have illustrated the extent of this effect in superabsorbent dressings (Eming et al, 2008).

Wiegand et al (2011) using Vliwasorb, have demonstrated this quantitative antibacterial effect. The authors compared two SAPs according to an international standard method (Japanese Industrial Standard, 2002; Monticello and Askew, 2013). Both SAPs were found to reduce numbers of *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, and *Escherichia coli* by over 3 log units, while growth of *Staphylococcus aureus* and *Candida albicans* was reduced by 2 log units. While this fails to show a difference between these two SAPs *in vitro*, it does not imply that all SAPs are of equal effect in this respect.

This bacterial sequestration mechanism would have the distinct advantage of not selecting for resistance as the function is purely physical. To what degree this applies to the many other SAPs on the market remains to be demonstrated, as does any *in vivo* or clinical significance.

CRITERIA FOR SELECTING A SAP

For optimal clinical and cost-effectiveness, the following selection criteria, based on the published literature and manufacturers' instructions for use, may prove helpful:

- **Wound exudate level:** Do not use on dry or lightly exuding wounds.
- **Wound bed preparation:** Application of the TIME framework (Leaper et al, 2012) to SAP

"The impact [of superabsorbent dressings] on infection via sequestration of bioburden is established **in vitro,** *but the clinical implications are yet to be demonstrated."*

clinical use indicates good moisture (M) control. Influence on inflammation (I) via MMP binding is established for some SAPs, but not all. The impact on infection via sequestration of bioburden is established *in vitro*, but the clinical implications are yet to be demonstrated. There is, as yet, no compelling evidence on tissue (T) by debridement, or promotion of granulation.

- **Delayed healing:** Those SAPs with proven MMP-binding and bacterial sequestration properties may have an impact.
- **Select size, shape, and adhesive/nonadhesive:** The available SAPs vary in this respect, select the most appropriate. Nonadhesive products will require fixation retention and so incur additional costs. One SAP product, the Eclypse boot, is available as a lower-leg enclosure, indicated for "leaky legs" as may occur with leg and foot ulcers and lympheodema (Rafter, 2011).
- **Wear time:** Extended wear time is not everything; dressings laden with exudate become heavy, dressing swelling leads to increased pressure, and the antimicrobial activity is likely to diminish with saturated dressings (Wiegand et al, 2013). Patients find heavy dressings uncomfortable and may wish to have hygiene performed more frequently to maintain quality of life.
- **Wound infection:** The bioburden reduction function of some SAPs has yet to be related to any clinical impact on critical colonisation or infection.
- **Compression:** Be aware of those dressings that swell and increase local pressure.
- **Patient preference:** Always consider the comfort and concordance of the patient when making dressing choices.
- **Ease of application and removal:** Dressing flexibility and conformability can be problematic on application.
- **Overall cost-effectiveness:** Unit dressing cost has been linked to fluid uptake (Cutting and Westgate, 2012). However, this is not formal cost-effectiveness. Not all dressings will be left *in situ* until they are saturated, so this calculation is not definitive. SAPs have been evaluated for clinical and cost-effectiveness in the treatment of venous leg ulcers by Panca et al (2013), who found sorbion sachet extra to be cost-effective when compared with KerraMax, Flivasorb, and DryMax Extra. WUK

REFERENCES

Allymamod A (2011) Evaluation of a 16-patient study using DryMax® Extra in four leg ulcer clinics. *Wounds UK* 7(4):57–61

Cook L (2011) Effect of super-absorbent dressings on compression sub-bandage pressure. *British Journal of Community Nursing* 16(Suppl3):S38–43

Cutting KF (2009) Managing wound exudate using a super-absorbent polymer dressing: a 53-patient clinical evaluation. *J Wound Care* 18(5):200–5

Cutting K, Westgate SJ (2012) Super-absorbent dressings: how do they perform in vitro? *Br J Nurs* 21(20):14–9

Dhodapkar R, Borde P, Nandy T (2009) Superabsorbent polymers in environmental redediation. *Global NEST Journal* 11(2):223–34

Eming S, Smola H, Hartmann B et al (2008) The inhibition of matrix metalloprotease activity in chronic wounds by a polyacrylate superabsorber. *Biomaterials* 29(19): 2932–40

Faucher N, Safar H, Baret M et al (2012) Superabsorbent dressings for copiously exuding wounds. *Brit J Nurs* 21(Suppl12):S22–8

Godar S, Guy H (2010) Managing highly exuding wounds with Eclypse dressings. *Brit J Nurs* 19(Suppl6):S24–9

Hampton S, Coulborn A, Tadej M, Bree-Aslan C (2011) Using a superabsorbent dressing and antimicrobial for a venous ulcer. *Br J Nurs* 20(15):S38–43

Hindhede A, Meuleneire F (2012) A clinical case-series evaluation of a superabsorbent dressing on exuding wounds. *J Wound Care* 21(11):574–80

Japanese Industrial Standard (2002) *Testing for Antibacterial Activity and Efficiency of Textile Products*. Japanese Standards Association, Tokyo

Leaper DJ, Schultz G, Carville K (2012) Extending the TIME concept: what have we learned in the past 10 years? *Int Wound J* 9(Suppl2):1–19

Lloyd-Jones M (2011) The role of Eclypse Adherent Sacral in managing sacral pressure ulcers. *British Journal of Community Nursing* 16(9):S38–42

Monticello RA, Askew PD (2013) Antimicrobial textiles and testing techniques. In: Fraise AP, Maillard J-Y, Sattar SA (eds) *Principles and Practice of Disinfection, Preservation and Sterilization (5th edn)*. Wiley-Blackwell, Oxford:520–9

Panca M, Cutting K, Guest JF (2013) Clinical and cost-effectiveness of absorbent dressings in the treatment of highly exuding VLUs. *J Wound Care* 22(3):109–18

Pytlik E, Molino D, Moritz J (2005) *Superabsorbent polymers*. Available at: http://bit.ly/14PSYDR (accessed 16.08.2013)

Rafter L (2011) Management of acute cellulitis with the Eclypse Boot. *Wounds UK* 7(4):62–8

Stephen-Haynes J (2011) Managing exudate and the key requirements of absorbent dressings. *British Journal of Community Nursing* 16(3):S44–9

Stephen-Haynes J, Stephens C (2012) Evaluation of a superabsorbent dressing in a primary care organisation. *British Journal of Community Nursing* 17:S36–41

Tadej M (2009) The use of Flivasorb in highly exuding wounds. *Br J Nurs* 18(15): S38–42

Verrall D, Coulborn A, Bree-Aslan C (2010) Evaluating a superabsorbent dressing (Flivasorb) in highly exuding wounds. *Brit J Nurs* 19(7):449–53

Wiegand C, Abel M, Ruth P, Hipler UC (2011) Superabsorbent polymer-containing wound dressings have a beneficial effect on wound healing by reducing PMN elastase concentration and inhibiting microbial growth. *J Mater Sci Mater Med* 22(11):2583–90

Wiegand C, Abel M, Muldoon J et al (2013) SAP-containing dressings exhibit sustained antimicrobial effects over 7 days in vitro. *J Wound Care* 22(3):120–7

Wiegand C, White R J (2013) Binding and inhibition of protease enzymes, including MMPs, by a superabsorbent dressing in vitro. *J Wound Care* 22(5):221–9

Wiegand C, Hipler UC (2013) A superabsorbent polymer-containing wound dressing efficiently sequesters MMPs and inhibits collagenase activity in vitro. *J Mater Sci Mater Med* [Epub ahead of print]

Wounds UK (2013) *Best Practice Statement: Effective Exudate Management*. Wounds UK, London. Available at: http://bit.ly/13qA7yf (accessed 16.08.2013)