Use of an antimicrobial primary wound layer with routine negative pressure wound therapy

KEY WORDS
- Antimicrobial
- Negative pressure wound therapy
- Surgical site infection

Surgical site infections (SSIs) pose wound management challenges to both the clinician and patient. An evaluation of three patients following surgical intervention with static wounds was conducted to explore the benefits of adding an antimicrobial primary wound contact layer in conjunction with negative pressure wound therapy (NPWT). All three patients demonstrated positive outcomes regarding atraumatic wound-bed protection, reducing bacterial burden, and "rebooting" of the wound healing process. The author recommends further research on the use of NPWT and antimicrobial primary wound contact layers for the management of SSIs be undertaken.

Surgical site infections (SSIs) are largely preventable but are one of the most common healthcare-associated infections and are increasingly becoming a national concern for all clinicians involved in surgical wound care (NICE, 2008). SSIs have a significant negative impact on NHS clinical and financial resources, reducing the quality of life for both the patient and carer, and have increasing associations with morbidity and extended hospital stay (Young, 2010).

There are many methods of managing SSIs from a tissue viability perspective, ranging from advanced wound care dressing products for exudate management, antimicrobial therapies for reducing the bacterial burden within the wound bed and mechanical devices, such as negative pressure wound therapy (NPWT), for difficult to stabilise, highly exuding large cavities.

This article will focus on the small evaluation of an antimicrobial hydrophobic wound-bed lining product in conjunction with routine NPWT used to promote an optimum environment for healing in three patients who presented with complex, nonhealing SSIs.

SURGICAL SITE INFECTION

An SSI occurs when bacteria multiplies within a surgical wound, which increases the risk of pain, inflammation, erythema and systemic fevers, biological markers resulting in delayed or static healing, and deeper tissue formation of abscess/collections (NICE, 2008). Bacteria will initially contaminate the wound through either endogenous or exogenous processes at the time of the tissue injury, with variance in contamination. Jeffery (2012) emphasises that the presence of devitalised tissue and or excess wound exudate will facilitate multiplication of the bacteria, thus increasing the risk of an infective state. In the UK, it is recognised within wound care that the most common contaminants of SSIs are *Pseudomonas aeruginosa, Staphylococcus aureus* and *Streptococcus pyogenes* with a combination of anaerobes and various coliforms (Bowler et al, 2001; NICE, 2008; Weigelt et al, 2010).

Factors that may negatively influence wound healing, increasing the risk of post-operative infection, are related to pre-operative skin preparation, patient age, comorbidities, skin and tissue viability, nutritional and hydration status, alongside the clinician's skill and knowledge in recognising when a wound is clinically accepted as infected (Mangram et al, 1999; Milne et al, 2012).

The median time for a wound infection to present either locally or systemically or in combination is 9 days (Leaper and Peel, 2003), with an accepted range of 7–10 days, post-incision (NICE, 2008). Due to increased day surgery cases, efficient shortened surgical procedures and early discharge, post-operative complications often occur when the patient is being cared for within the community setting rather than the acute sector (Melling et al, 2005).

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DECLARATION OF INTEREST
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"The clinical benefits of negative pressure wound therapy are to improve efficiency in blood flow to the wound bed, aid waste product removal, increase granulation tissue within the cavity aiding epithelial cell migration, and – ultimately – achieve wound closure."

Box 1. Summary of organisms that bind irreversibly to Cutimed® Sorbact® (BSN medical) in a moist environment.

- *Bacteroides fragilis*
- *Candida albicans*
- *Citrobacter freundii*
- *Clostridium perfringens*
- *Enterobacter cloacae*
- *Enterococcus faecalis*
- *Escherichia coli*
- *Klebsiella (K. pneumoniae, K. oxytoca)*
- *Morganella morganii*
- *Peptococcus magnus*
- *Proteus mirabilis*
- *Pseudomonas aeruginosa*
- *Staphylococcae (S. aureus, S. epidermidis, S. haemolyticus,* methicillin-resistant *S. aureus)*
- *Streptococcae* (Group A, Group D, viridans Streptococcae)

With an estimated annual rate of 11 million acute surgical procedures being performed within the UK (Department of Health [DH], 2009), 5% are estimated to develop an SSI following surgical interventions across all specialities, thus increasing the financial and clinical resource burden on the NHS, which is currently estimated at £1.6 billion annually (Smith, 2010). Readmission rates and the number of patients requiring further corrective surgical interventions are on the increase, thus impacting on routine and emergency service provisions with reduced bed availability alongside DH-enforced financial penalties if readmitted within 30 days (Young, 2010). The social, psychological, and financial impacts on the patient and carer are immeasurable.

NEGATIVE PRESSURE WOUND THERAPY

NPWT plays a role in the management of surgical wounds at risk of infection, and of chronic wounds that have failed to heal through primary intention. Generally, all available NPWT devices perform using the same principles: a foam or gauze is deployed within the wound cavity, sealed with an adhesive film creating a seal which is connected to a vacuum (Gregor et al, 2008). It is highly recommended by key leading specialists who regularly use the therapy that the wound bed is prepared adequately and that, where possible, necrotic tissue is removed prior to application to enhance wound healing and recovery (Vowden et al, 2007; Jeffery, 2012).

The clinical benefits of NPWT are to improve efficiency in blood flow to the wound bed, aid waste product removal (Orgill et al, 2009), increase granulation tissue within the cavity aiding epithelial cell migration, and – ultimately – achieve wound closure (Morris et al, 2007). Removal of excess wound exudate containing inhibitors such as cytokines and proteinases, alongside effective mechanical action and wound contraction and reduction are induced, thus providing an optimum environment for wound healing to occur (Orgill and Bayer, 2011). Guy and Grothier (2012) suggest that caution is to be taken by clinicians when employing NPWT for patients with contraindications to its use (*Table 1*), as this may further increase risk of damage occurring to the vulnerable tissue, thus reducing wound healing.

Table 1. Contraindications and cautions for the use of negative pressure wound therapy (Smith & Nephew, 2011).

Contraindications
Untreated or complicated osteomyelitis
Exposed blood vessels, organs and or unexplored fistulae
Open joint capsules
Nonpalliative malignancy
Necrotic/eschar tissue
Cautions
Visible fistula
Exposed mechanical implants
Risk of bleeding
Compromised microvascular blood flow to wound

Many of the NPWT kits provide the clinician with a wound-bed contact layer that is not antimicrobial in action, but one that acts as a barrier to prevent adhesion of the accompanying foam or gauze promoting atraumatic removal and therefore protection of underlying structures (Guy and Grothier, 2012).

The Cutimed® Sorbact® (BSN medical) product range has active antimicrobial capabilities with no demonstrated bacterial resistance, as seen with other antimicrobials (i.e. silver). It has an innovative hydrophobic action which effectively removes microbes from the wound bed that otherwise may result in delayed wound healing (Meberg and Schøyen, 1990).

Cutimed Sorbact dressings are coated with dialkylcarbamoylchloride (DACC), a fatty acid derivative that makes the dressing highly hydrophobic. Once in physical contact with the wound bed, and in the presence of moisture, such as wound exudate, bacteria that are also hydrophobic in nature, are attracted away from the wound by the DACC coating and become bound to the dressing (*Figure 1; Box 1*), thus reducing the overall concentration of microbes in the wound.

The product can be used for many types of wounds, is effective on all common wound pathogens and fungi and can be used by any patient group; however, the wound must have some degree of moisture for the dressing to facilitate the hydrophobic properties and bacteria

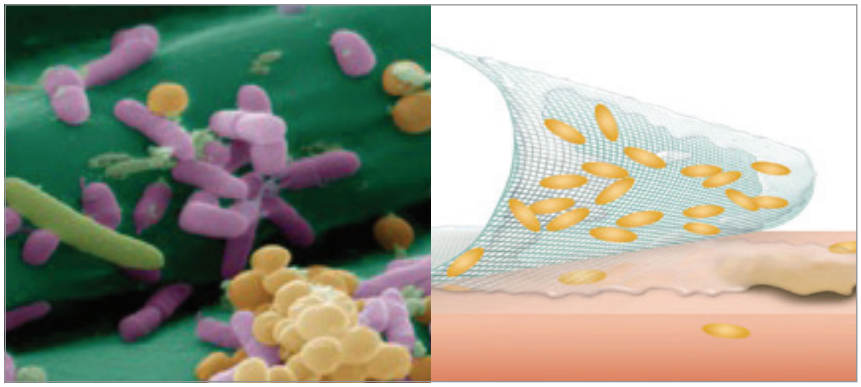
capture and to prevent adherence to dry areas of tissue. The product can be used as a primary dressing beneath any secondary dressing regimens except those that have a cream or emollient substance content, which can reduce its efficacy by providing a physical barrier to the wound bed (Hampton, 2007).

METHODS

Following referral of three patients with complex SSI static cavities into the South Tees NHS Hospitals Foundation Trust wound care service, the patients agreed with (giving verbal consent) the referring consultant surgeons (who had undertaken the original surgery) to evaluate the introduction of the Cutimed Sorbact swab as an additional dressing product into their NPTW regimen. This product was selected for its antimicrobial benefits and low adherence properties, and as the author had experience with its successful use in previous patients with chronic leg ulcers.

The Cutimed Sorbact swabs were used to line the cavity wound bed and walls prior to NPWT application, with the normal regimen of cleansing with sterile saline using an aseptic technique and vacuum closure. Wound assessment and documentation was undertaken by the senior wound care lead prescriber who did not undertake the dressing care for the three patients to ensure that consistency within the data collection process was accurate and objective.

Figure 1. Cutimed® Sorbact® hydrophobic action on micro-organisms (images courtesy of BSN medical).



RESULTS

Pre-evaluation data are shown in *Table 2.* All three patients had undergone a major surgical intervention, had extended hospital stay due to positive microbiology infection and resulting dehiscence, and had NPWT already employed to manage high levels of wound exudate. All wounds had become static, and all had positive wound-bed swabs taken <1 week prior to the study intervention.

Table 2. Patient pre-evaluation summary

	Patient A	Patient B	Patient C
Age (years)	36	69	89
Sex	Male	Female	Female
Comorbidities	Bariatric, type 2 diabetes, depression, sepsis on admission	Ischaemic heart disease	Transient ischaemic attack, type 2 diabetes, immobility, vascular insufficiency
Surgery	Left above-knee amputation	Right hip replacement following fall and NOF fracture	Right groin dehiscence following revascularisation of right limb
Duration of standard NPWT (days)	21	28	32
Microbiology	*Enterbacteria*, faecal flora	*Staphylococcus aureus*	*Pseudomonas aeruginosa*
Systemic antibiotics	Intravenous	Intravenous	Intravenous
Wound description	50% soft necrosis, thick slough, strong malodor, macerated periwound skin, high levels of exudate (850 mL at 72 hrs)	Sloughy, mild malodor, minor soft necrosis, macerated periwound skin, moderate levels of exudate (250 mL at 72 hrs)	Sloughy, strong malodor, high levels of exudate (600 mL at 72 hrs)
Wound size	23 cm L × 15 cm W × 5 cm D	7 cm L × 2 cm W × 4 cm D	8 cm L × 8 cm W × 5 cm D

D, depth; L, length; NOF, neck of femur; NPWT, negative pressure wound therapy; W, width.

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All three patient's wounds progressed by week 2, with no evidence of slough, malodor, or necrosis, and >50% reduction in exudate levels for two patients (*Table 3*). All three patients had negative microbiology swabs by week 3, with no change of their antibiotic or other regimens prior to this. At this time, two of the patients discontinued systemic antibiotics and NPWT; the remaining patient was switched from intravenous to oral antibiotics, and NPWT was maintained for a further 7 days, until exudate was manageable with basic foam dressings. By week 6, all three patients' wounds were being managed with conventional, low-cost dressings in the community.

DISCUSSION

When used in conjunction with NPWT in the three SSI cases reported here, Cutimed Sorbact was found to provide atraumatic wound-bed protection, reduce local bioburden, and aid "rebooting" of the wound healing process. Cutimed Sorbact is by no means an alternative to systemic antibiotic therapy, but arguably has a role to play as an adjunct therapy in the management of SSI.

The product cost is minimal in comparison with other nonadherents that are currently used under NPWT that do not have an antimicrobial action. The product can be left within the wound bed for up to 7 days, thus potentially reducing cost further.

CONCLUSION

All three patients reported here demonstrated positive outcomes following the incorporation of Cutimed Sorbact into their SSI management regimens. The author acknowledges that this is a small evaluation and recommends further research into the use of NPWT and antimicrobial primary wound contact layers for the management of SSI. WUK

Table 3. Patient evaluation summary.

Evaluation time	Patient A	Patient B	Patient C
Day 4	700 mL of exudate, mild malodor, reduced slough, peri-wound skin intact	220 mL of exudate, minor necrosis/slough less viscous, no malodor, peri-wound skin intact	550 mL of exudate, sloughy, reduced malodor
Week 1	650 mL of exudate, no malodor, reduced slough	200 mL of exudate, no slough, no malodor	480 mL of exudate, minimal slough present
Week 2	380 mL of exudate, granular tissue visible	200 mL of exudate, clean wound, no visible granulation	250 mL of exudate, no slough, clean wound, no visible granulation
Week 3	200 mL of exudate, visible granulation, wound size reduction, NPWT discontinued, Cutimed Sorbact conventional dressings implemented, systemic antibiotics discontinued	200 mL of exudate, visible granulation, minimal wound size reduction, NPWT continued, systemic antibiotics switched to oral	140 mL of exudate, visible granulation, NPWT discontinued, Cutimed Sorbact conventional dressings implemented, systemic antibiotics discontinued
Microbiology	Negative swab	Negative swab	Negative swab
Week 4	17 cm L × 10 cm W × 1 cm D	6 cm L × 1 cm W × 3 cm D, NPWT discontinued, conventional Cutimed Sorbact dressings implemented	3 cm L × 3 cm W × 2 cm D
Week 5	–	4 cm L × 0.3 cm W × 1 cm D, basic adhesive pad dressing	2 cm L × 1 cm W × 0.5 cm D, basic adhesive pad dressing
Week 6	10 cm L × 5 cm W × 0.8 cm D, basic adhesive foam dressing	Discharged	Discharged

D, depth; L, length; NPWT, negative pressure wound therapy; W, width.