

The Sorbact® Portfolio of Wound Dressings in the Management of Wound Healing and Prevention of Infection: A Narrative Review

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Abstract

The Sorbact portfolio of wound dressings has a unique mechanism of action that utilizes of dialkylcarbamoyl chloride (DACC). DACC is highly hydrophobic and in conjunction with the hydrophobic nature of bacterial cell walls mediates irreversible binding of micro-organisms to the surface of the dressings. When Sorbact is applied directly to the wound, bacteria (and fungi) that are bound to its surface are removed at each dressing change.

The aim of this review was to present the clinical data on the use of the family of Sorbact (DACC-coated) dressings in the treatment of a variety of acute and chronic wounds. The findings are discussed in terms of the effectiveness of Sorbact for bacterial bioburden reduction, infection prevention, initiation/progression of wound healing and cost-effectiveness. The evidence in support of Sorbact is strongest in the area of infection prevention in surgical wounds, with several controlled trials showing the prophylactic benefit of the dressing in these wounds. Wound bioburden management in chronic wounds is supported by a number of clinical studies. In total 29 published clinical studies (with a total of 4044 patients) were included in this review.

Key Words: Sorbact, Dialkylcarbamoyl chloride (DACC), Hydrophobic, Bacterial bioburden, Irreversible binding, Surgical site infection, chronic wound infection

Introduction

A wound occurs when the integrity of the skin is broken, this injury usually heals via a series of four distinct but overlapping phases: haemostasis, inflammation, proliferation and granulation/remodeling.¹ However, skin wounds that are slow/do not heal and recur become chronic wounds and these wounds may be more susceptible to infection.^{2,3} This presents a significant clinical challenge^{4,5} and bacterial contamination and infection can further delay healing.^{6,7} Any wound can become colonised by microorganisms and this may lead to infection, but some wounds are more prone to the risk of infection than others. Patients with 'high-risk' wounds tend to have other concomitant factors (e.g., old age, poor nutritional status, co-morbidities or immune deficiencies) that compromise the patient's ability to combat pathogenic bacterial infiltration/proliferation that results in infection.⁸⁻¹⁰ Wounds at a high risk of infection include surgical wounds and chronic wounds and are discussed below.

Surgical Site Infections (SSI): SSIs are the most common type of hospital-acquired infection and can be defined as occurring at a part of the body where surgery has taken place within 30 days of the procedure, or within 1 year of the procedure if a prosthetic surgical device was implanted.¹¹ Europe-wide, SSIs accounts for up to 20% of all hospital-acquired infection¹² with figures from England suggesting that SSIs are the third-most common healthcare-associated infections.¹³ The incidence of SSIs varies according to the type of operation with the highest percentages in colon surgery (9.6%) and the lowest in knee prosthesis procedures (0.8%).¹⁴ One in 3 postoperative deaths are related, at least in part, to the presence of an SSI.¹⁵ The presence of an SSI can lead to additional costs, as highlighted in a recent systematic review across six European countries that investigated the impact of SSI on healthcare costs and patient outcomes.¹⁶ The results of the review demonstrated that SSI:

- were consistently associated with elevated costs, compared with uninfected patients
- patients required prolonged hospitalization, reoperation, readmission
- were associated with increased mortality rates

Chronic wounds: Chronic wounds are a significant challenge to the clinician and to the patient that suffers from them. In developed countries, it is estimated that 1 to 2% of the population will experience a chronic wound in their lifetime,¹⁷ although other studies suggest chronic wounds have a prevalence of as high as 6%.¹⁸ Older adults are at the highest risk for chronic wounds due to a combination of a slowing wound healing with age^{19,20} and an increase in the incidences of

cardiovascular disease and diabetes (associated with an increased incidence of chronic wounds).²¹ In addition, chronic wound infections are also responsible for considerable morbidity and significantly contribute to the escalation in resource use and costs.^{22,23} Infection is the likeliest single cause of delayed healing in healing of chronic wounds.²⁴ A recent evaluation of the impact and cost of chronic wounds in Medicare beneficiaries, Nussbaum et al. reported almost 15% of Medicare beneficiaries had at least one type of wound or infection.²² After surgical infections, diabetic wound infections were the next largest prevalence category (3.4%). Venous infections had a prevalence of 2.3%.

Treatment of wound infection is generally undertaken using a combination of topical antiseptics (e.g., silver) and/or systemic antibiotics. Antiseptics such as iodine, honey and silver have a disruptive or biocidal effect on bacteria, fungi and/or viruses with multiple sites of antimicrobial action on target cells and therefore have a low risk of bacterial resistance. Topical antiseptics are non-selective and therefore may be cytotoxic causing damage to the many cell types involved in healing, thereby impairing the healing process.²⁵ The use of topical antibiotics, for example topical metronidazole gel, silver sulphadiazine and Mupirocin, is controversial with regards to the global concern regarding antibiotic resistance, and the use of topical antibiotics for wound management should only be considered in infected wounds under very specific circumstances.²⁵ A holistic approach to those with, or at risk of, wound infection is the best practice in prevention and management of wound infection,²⁵ and is particularly important regarding antibiotic resistance. The development and use of treatments for wound infection that do not involve the use of antibiotics is essential. Both antiseptics and antimicrobials are used to kill/reduce the level of bacterial by “active” mechanisms such as the damaging the bacterial cell wall.²⁶ Alternatively, the use of regimens that rely on a physical mode of action has also proved to be effective in wound bioburden management and there is no risk of bacteria developing resistance.²⁷ Dialkylcarbamoyl chloride (DACC), a fatty acid derivative, is an example of a physical mode of action for reducing wound bioburden. This review explores the clinical evidence that supports the use of Sorbact as an alternative to active treatments in the management/prevention of wound infections and reducing wound bioburden.

Sorbact

When two water-repellent (hydrophobic) surfaces come into close proximity, they bind with one another by hydrophobic interaction and expel water molecules (Figure 1). This is despite there being no force or attraction between the surfaces. DACC is a highly hydrophobic substance that coupled with the hydrophobic nature of bacterial cell walls mediates the irreversible binding of microorganisms to DACC-coated dressings. When applied directly to the wound bed this results in binding of bacteria and fungi to the dressing surface.²⁸ The Sorbact-bound microorganisms are subsequently removed at dressing change resulting in a decrease in wound bioburden.²⁸ Rather than killing the bound microorganisms (as would happen with antibiotics or antiseptics), the physical binding means that their cell walls remain intact avoiding release of endotoxins. The binding of microorganisms from the wound bed makes the development of resistance unlikely, no absorption of DACC into the wound environment is known to occur, and clinical studies have reported an excellent safety profile when using Sorbact dressings.²⁹⁻³¹

Methods

Searches of internet reference databases (e.g., MEDLINE) were undertaken to identify published articles describing clinical data relating to the use of DACC-coated dressings or Sorbact in the treatment of infection and support of healing in surgical, acute wounds (e.g., burns) and chronic wounds. The search covered the period January 1970 to November 2018. In addition, manual searches of relevant (e.g., wound care) journals not indexed in online reference databases were performed. All articles investigating the use of DACC-coated dressings Sorbact in wound care with primary and/or secondary outcomes related to infection and or healing were reviewed.

This overview takes the form of a 'narrative overview' that summarises the data from each reviewed article.³² Data from both randomized and non-randomized trials, cohort studies and case series reports were included. Only full text reports regarding human subjects and in the English language were included. Articles of a case series of fewer than three cases were also excluded.

Results

The key evidence articles are summarised in Tables 1 and 2.

Surgical site infection (SSI)

SSIs have been consistently identified as the third most common healthcare-associated infection in the UK (after pneumonia and urinary tract infection) and are associated with considerable morbidity, mortality and costs.^{16,33,34} A recent systematic review confirmed that a significant number of SSIs occurred following various surgical procedures in European countries.¹⁶ The incidence of SSI was as high as 36% in one of the studies reviewed, demonstrating that infections constitute a persistent

complication of surgery and a financial burden.³⁵ Furthermore, it has been reported that, in England, the mean total cost of orthopedic and trauma surgery in those who developed an SSI was about 2.9 times higher than the costs associated with patients who did not.³⁶ At least 5% of patients undergoing a surgical procedure develop SSI, adding three days hospital stay and additional cost (e.g., £4-10k).³⁷ The annual incidence of infected chronic wounds in the UK has been reported as up to 500,000 cases per year³⁸ with incidence of SSI being reported as being at least 16%.¹³ In the United States, SSI contribute to patients spending more than 400 000 extra days in hospital at a cost of an additional US\$ 900 million per year.³⁹ Table 1 and Text Box 1 summarise the key clinical evidence in support of Sorbact in the treatment of SSIs.

Cesarean surgery

Surgical Site Infection is one of the most common complications following cesarean section and has an incidence of 3%–15%.⁴⁰ It significantly affects the mother's well-being and is a weighty financial burden on the healthcare system.⁴¹ Post-cesarean SSI is associated with a maternal mortality rate of up to 3%.⁴⁰ The use of cesarean section is increasing globally, and it is probable that there will be a parallel increase in the occurrence of SSI. Therefore, developing strategies to diagnose, prevent, and treat SSI are essential for reducing post-cesarean morbidity and mortality.⁴⁰ The use of Sorbact Surgical dressing in reducing levels of infection in cesarean surgery has been reported. In a clinical study undertaken Stanirowski et al.⁴² patients undergoing caesarean section were randomized to either Sorbact Surgical Dressing or standard dressings. The patients were followed-up for 14 days post-surgery and the presence of superficial or deep SSI was assessed. Initially the results reported as a pilot study,⁴³ demonstrated an SSI rate of 2.8% (Sorbact) compared with 9.8% (Standard dressing) group ($p=0.08$). Also, patients receiving a standard surgical dressing and who had an SSI required systemic antibiotic therapy significantly more frequently than those receiving treatment with Sorbact ($p=0.03$). The full RCT reported overall SSI rates of 1.8% with Sorbact compared with 5.2% in standard surgical dressings ($p=0.04$).⁴²

Stanirowski et al. further examined costs related to treatment in each of the two groups. The results clearly demonstrated that the total cost of SSI prophylaxis and treatment was greater in the control group versus Sorbact treated patients (5775EUR vs. 1065EUR, respectively - Figure 2.). Specifically, in the Sorbact treated group costs related only to ambulatory visits, had fewer outpatient visits, fewer hospital bed-days and no women required hospitalization for infection. Whereas in the control group total cost encompassed prolonged hospitalization, additional nursing care and systemic antibiotic treatment.

Vascular surgery

Although a major source for vascular surgery infections is by bacteria transference with vascular graft tissue,⁴⁴ patients undergoing non-implant surgery – as with most surgical procedures – are also prone to infection via the surgical procedure. In a recent (non-randomised comparative) study, the use of Leukomed Sorbact was shown to be an effective treatment in this indication.⁴⁵ In this study, the effect of DACC-coated dressings on the incidence of SSI in non-implant vascular surgery patients was evaluated. Two groups of patients (n=100 in each group) were treated post-operatively either with conventional dressings or Leukomed Sorbact. The results highlighted that rates of SSI at 5-7 days was significantly lower in Leukomed Sorbact group compared with the standard dressings (1% vs. 10%, p<0.05). Only a single patient in the DACC dressing group required 7 days of intravenous antibiotic, whilst in the conventional dressing group, all 10 patients with SSI at day 5-7 were treated with antibiotics: two of these patients required intravenous antibiotics and the other 8 patients were treated with oral antibiotics.⁴⁵ There was no difference in the rates of SSI at 30 days.

Skin Grafting

A skin graft is defined as removal of healthy skin from an unaffected area of the body and used to cover an area where the skin has been lost or damaged.⁴⁶ Split-thickness skin grafting involves only the epidermis and a very thin layer of underlying dermis as part of the graft, thus maximizing the opportunity for healing of the new graft to occur.⁴⁷ In order that the graft will 'take' (i.e. become incorporated into the host bed), the wound bed must be prepared to minimize the risk of infection.⁴⁸ However, infection is a significant problem that can cause graft failure and prevention or treatment of infection is a requirement for optimizing graft take.⁴⁹ The use of DACC-coated hydrogel dressings for fixation of grafts after surgery was assessed in a 7-patient evaluation.⁵⁰ After treatment with the DACC-coated dressing and a tie-over dressing (fine cotton gauze to help secure primary dressing in position), the wounds were assessed for infection at 5, 14- and 30-days post-surgery. No SSIs were observed.

In a parallel three-arm prospective RCT (n=101),⁵¹ Sorbact was compared with two other dressings, including a calcium alginate (the most commonly used donor site wound dressing),⁵²⁻⁵⁴ in treating non-infected donor sites in paediatric split-thickness skin grafting. The investigators found that the three dressings performed equally well when compared.⁵¹ Donor sites dressed with Sorbact had a mean time to re-epithelialisation of 7 days which was not statistically different compared with the other dressings, including the alginate dressing (p>0.05). There was also no statistical difference between the 3 dressings in pain scores. The authors concluded that there was no evidence for a preference between dressings.

Umbilical Cord Care

During birth, the umbilical stump can become infected and, if not treated promptly, a more severe, systemic infection can occur which may lead to death (estimated mortality rate between 7% and 15%).^{55,56} The use of aseptic techniques during delivery, proper cord care, and the use of chlorhexidine as a topical agent has been shown to reduce the risk of cord infection.⁵⁶ In a prospective, randomised study in newborn infants there was no significant difference in the incidence of infections between the DACC-coated dressing and the chlorhexidine-ethanol-treated group - 16.3 vs. 14.6% respectively, $p>0.05$.⁵⁷

Negative Pressure Wound Therapy (NPWT)

Negative pressure wound therapy involves the controlled application of sub-atmospheric pressure to the local wound environment using a sealed wound dressing connected to a vacuum pump. It has been shown to be a very effective form of treatment in difficult-to-heal or static wounds.⁵⁸ Generally, foam or gauze dressings have been used as wound fillers to help deliver negative pressure to the wound bed and to help distribute the pressure equally across the wound surface.⁵⁹ Liners have been used to help avoid adherence and to aid in the atraumatic removal of the fillers. In some instances, these liners may also have “active antimicrobial agents aimed to reduce levels of infection in these wounds”.⁶⁰

Evidence to support the use of Cutimed Sorbact in conjunction with NPWT and as an aid to reducing infection in complex abdominal wounds has been reported by several authors (see Table 1). Bateman⁶¹ investigated the use of Cutimed Sorbact as a wound contact layer in conjunction with NPWT in 10 patients with heavily infected, exuding wounds of various etiology (including 5 surgical wounds). All wounds had previously been treated with NPWT but the wounds had not progressed. The DACC-coated dressing was used to line the wound bed and the walls of any wounds with significant depth and the regular NPWT regimen was followed. The DACC-coated liner remained in situ and was replaced every 7 days. ‘Negative microbiology’ was reported in 60% (n=6) of patients at week 1 and in all patients (n=2) at week 2. Wound exudate production also decreased by week two in all patients, and there was a mean reduction (40%) in wound size.

In a case series of 7 patients with surgical wounds, Jeffrey⁶⁰ reported preliminary clinical evidence of the use of Cutimed Sorbact as an alternative to foam and gauze during NPWT. The author felt that there was a significant improvement of the wounds (e.g., progression to healing) in the quality of life of the patients (e.g., ability to carry out daily activities).

Burn Wounds

In 2004, the WHO Global Burden of Disease report estimated that approximately 11 million people per year had burn injuries that were serious enough to seek medical attention – placing burn injury as the fourth most common substantial injury.^{62,63} In the UK, it is estimated that each year about 250,000 people with burn injuries present to primary care teams⁶⁴ and the number of burns-related deaths in the UK averages 300 a year.⁶⁵ Invasive infection in burn wounds is prevalent and is a significant cause of mortality and is now the chief reason for death and morbidity after burn injury, with it being responsible for 51% of the deaths.⁶⁶

In a randomized prospective study of 13 patients with partial- or full-thickness burn wounds, the effectiveness of Cutimed Sorbact was compared with two silver-containing dressings.⁶⁷ The results showed no differences between the “active” silver dressings and Cutimed Sorbact in terms of level of infection parameters assessed, but the investigators noted that burns dressed with Cutimed Sorbact appeared subjectively cleaner and had less bacterial growth compared with the comparators. Based upon this study, and the finding that partial-thickness burn wounds appeared to progress under Sorbact, Kleintjes et al.⁶⁸ examined 27 patients with partial-thickness burns treated with Cutimed Sorbact as a “skin substitute”. Treatment was followed for up to 28 days and by final assessment wounds appeared clean (59%), dry (51%), pink (51%) and healed (27%). The authors concluded that Cutimed Sorbact was a cost-effective skin substitute for treating burn wounds in their facility.

Chronic Wounds

The failure of a wound to heal is the result of a complex series of abnormalities both in the patient’s underlying aetiologies as well as within the wound bed. Infection is a major contributor to chronicity, and wounds with a significant bioburden often show healing failure.^{69,70} The devitalized tissue within the chronic wound bed is a focus for bacterial colonization and proliferation. As such, it can act as a nidus for infection which can be exacerbated if the patient also has an impaired host immune response (e.g., when inflammatory cells are unable to easily access devitalized tissue). Treatment of infection in chronic wounds is therefore of great importance and generally includes thorough debridement to remove dead, devitalized tissue and the use of antimicrobial therapy (e.g., silver-containing wound dressings).² Table 2 and Text Box 2 summarise the key evidence in support of the use of Sorbact in the treatment on chronic wounds.

Leg Ulcers

Sorbact-technology has been shown to be effective in the treatment of chronic wounds. For example, in a multicenter clinical evaluation, patients with venous leg ulcers (n=63) were treated with Cutimed Sorbact and changes in wound status and the wellbeing of the patients were

evaluated.⁷¹ The results showed that after treatment with Cutimed Sorbact 85% of wounds either healed or reduced in size (44-92% reduction). In addition, infections were suspected in 48% of patients and there was an overall reduction in the signs of infection (redness) with dressing treatment, and no antibiotics were required.

Cutimed Sorbact has also been shown to be effective in a non-comparative double-blind study in patients (n=19 patients/20 wounds) with infected arterial and venous leg ulcers.⁷² In this study, bacterial load, wound size, wound condition and quality of life were assessed. The wounds were surgically debrided and then treated with Cutimed Sorbact for 4 weeks. Punch biopsies of wounds were taken at the beginning and end of the assessment period and assessed for bacterial load. After the 4-week assessment period, there was a significant improvement in 7 wounds (77.5% average area reduction), two of which healed completely, and 8 wounds improved (>50% reduction, mean reduction 38.3%). Bacterial burden decreased significantly in 10 out of 15 (66.7%) healing chronic wounds and remained unchanged in 5 out of 5 non-healing chronic wounds.

Mosti et al. reported a randomised, comparative study on patients with critically colonized or locally infected leg ulcers comparing Cutimed Sorbact with a silver-containing hydrofibre dressing group (n=20 in each group).²⁹ The results showed that there was a significant reduction of bacterial bioburden on day 4 in both groups (compared to baseline) but that the Cutimed Sorbact treated group demonstrated the more effective response with an average bacterial load reduction of 73.1% vs 41.6% in the silver-containing dressing group (p<0.00001) (Figure 3).

In a non-randomised, multicentre evaluation, Kammerlander et al. assessed the efficacy of Cutimed Sorbact in the management of chronic wounds of different types.⁷³ Of the 116 patients enrolled on the study, 84% had signs of wound infection at the start of the study and after treatment with Cutimed Sorbact, 81% of these wounds showed no signs of infection (Figure 4). The healing response was equally as positive. With Cutimed Sorbact treatment, 21% of all wounds went on to heal by the end of the study, and there was wound healing improvement in a further 72% (Figure 5).

The authors were positive regarding results seen with Cutimed Sorbact and stated that *“Despite initial scepticism, Cutimed Sorbact achieved a good level of efficacy as an antimicrobial product within a phased programme of wound care. Using Cutimed Sorbact in this study, 81% of wounds showing signs of infection at the start of treatment were healed and in 93% of cases there was an improvement in wound healing or a complete cure.”*

Chronic wounds are associated with high treatment costs and data from Germany suggests that wound dressings are the main cost-drivers in venous leg ulcer care.^{74,75} A budget impact analysis was

performed comparing three different scenarios of the 'intervention mix' of antimicrobial dressings (including Cutimed Sorbact, silver- and PHMB-containing dressings). A Markov model estimated VLU progression for one year which demonstrated that an increased use of Cutimed Sorbact reduced costs in both drug and dressing expenses, with the impact increasing over the course of 12 months.

The use of DACC-coated dressing in 50% of target patients leads to a higher number of healed ulcers and ulcers without wound infection within a year and lowering overall cost per patient.⁷⁶ Grothier and Stephenson audited a clinical pathway for identifying and managing wound infection in a community nursing service.⁷⁷ The audit data suggest that managing patients appropriately (e.g. with Cutimed Sorbact) and preventing infection reduces the use of expensive antimicrobials and other dressings. Hardy reported on the use Cutimed Sorbact and Cutimed Siltec in the management of patients with lymphoedema, chronic oedema and lymphorrhoea.⁷⁸ The author describes that the implementation of the above products to achieve bioburden management resulted in improved wound healing, the patients' quality of life and significant reduction in the cost of care. Derbyshire reported on a series of three case studies that there were significant cost savings in the treatment of chronic wounds with DACC-coated dressings (Cutimed Sorbact and Cutimed Siltec).^{79,80}

Pressure Ulcers (PU)

Pressure ulcers form when an area of skin is placed under constant pressure (e.g. on tissues over bony prominences) for a prolonged period and compression and/or shear forces results in local tissue damage.⁸¹ Pressure ulcers are prone to infection⁸² and, as with all chronic wounds, removal of infection is a priority for healing to progress.

Sorbact has been shown to be effective in the treatment of infected PU as can be seen in a comparative study, whereby patients (n=33, with 36 PU) were randomized into either the control group (n=14) or a Sorbact dressing group (n=19).⁸³ The study monitored wound bed colour, peri-wound oedema and erythema, autolytic debridement as well as changes in signs of infection. Both groups received the same treatment appropriate to local guidelines (control group) except for inclusion of Sorbact in the test group. The results demonstrated a significant reduction in peri-wound oedema/erythema in patients treated with Sorbact vs. the control group (78% vs. 57% respectively, p=0.028). Wound bed improvements were seen in wound bed colour (95% vs. 72%, Sorbact vs. control group, respectively, p=0.034), and Sorbact also aided wound debridement and faster healing time (9 ± 2 days vs. 11 ± 2.1 days, p=0.041).

Diabetic Foot Ulcers (DFU)

Foot disease affects nearly 6% of people with diabetes⁸⁴ and is linked to infection, ulceration, or destruction of tissues of the foot.⁸⁵ It can significantly impair the well-being of patients affected and impacts many social aspects of their lives including their day to day work.⁸⁶ Ulceration is common in diabetic patients with prevalence as high as 25% and as a result between 0.03% and 1.5% of patients will require an amputation.^{87,88} Most amputations start with ulcers but can be prevented with good foot care and screening to assess the risk for foot complications.⁸⁸ Despite this, infection is commonplace, occurring in up to 25% of patients and costly.⁸⁹ Consequently, it is imperative to prevent/treat infection in DFU effectively and quickly.

Evidence in support of the use of DACC-coated dressings to treat DFU has been reported in a (non-randomised single-centre open) Case Series of infected/at-risk chronic DFUs.⁹⁰ In this study, patients (n=19, 29 wounds) were treated with DACC-coated dressings to evaluate the dressing's ability to reduce the signs and symptoms of infection. At the beginning of the study, 76% (22/29) wounds (mean duration, 11 months) showed two or more signs of infection (e.g., erythema, heat, oedema, pain, malodour, high exudate levels). These patients were treated over a 4-week period (or until the wound had healed) and at completion of the study 100% of wounds demonstrated a reduction in size and pain, with most wounds showing no signs of infection. There are also several case reports relating to the successful use of Cutimed Sorbact for the management of infection in wounds of the diabetic foot⁹¹ and the use of Sorbact ribbon treating interdigital fungal infections in diabetic patients.³⁰ Additionally, a number of reports have presented evidence to the successful treatment of infection and the support of healing in a variety of chronic wounds (including DFU, VLU and PU) with Cutimed Sorbact,^{31,77,92,93} Cutimed Sorbact Hydroactive⁹⁴ and Cutimed Siltec foam/Cutimed Sorbact gel dressings.⁹⁵

Discussion

The aim of this review was to present clinical data reporting the use of Sorbact (DACC-coated) dressings in the prevention and management of wound infection and to reduce wound bioburden, two areas were the primary focus, SSIs and chronic wounds.

SSI is the most common type of hospital-acquired infection. Even with many precautions and protocols to prevent infection in place, any surgical procedure can lead to infection. SSI accounts for up to 20% of all hospital-acquired infection and occurs in at least 5% of all surgical procedures.¹⁵ Morbidity and mortality due to SSI can be devastating but could be preventable with appropriate strategies and policies in preoperative, intraoperative, and postoperative patient and wound care.¹⁵

A RCT reported a significant reduction in the SSI rates in patients undergoing caesarean section when wounds were dressed with Sorbact Surgical (DACC-coated) dressings compared with standard surgical dressings.⁴² The use of Sorbact Surgical for reducing SSI rates was also reported in a prospective comparative study in 200 patients undergoing non-implant vascular surgery.⁴⁵ Bua et al. comment that the maximal protective effect of the DACC-coated dressings appears to be in the early post-operative period and suggest that this may be due to the prevention of ingress of bacteria into freshly created wounds by the dressing.⁴⁵

A significant proportion of chronic wounds has been shown to be clinically infected.^{96,97} The Sorbact portfolio (DACC-coated) of wound dressings can manage established wound infection and decrease bacterial load when used as part of the treatment regimen for a variety of infected acute and chronic wounds^{29,67,72} and prevents infection in high-risk patients.⁷⁷ The management and resolution of already-established infections of wounds helps to optimize the wound environment and to aid the establishment of wound progression in previously static wounds. Removal of bacteria by Sorbact dressings improves the quality of the wound bed⁸³ leading to an improved healing response^{31,93} and promotes healing.⁹² Other benefits identified in the clinical studies include improvements such as reduced pain experienced by patients treated with Sorbact^{31,73,78,90-92,94} and a reduction in wound malodour.^{73,78,90,92,94} Reducing the level of microorganisms in the wound bed has a beneficial effect on the local wound environment, removing barriers to healing progression and optimizing the local environment.

The mechanism of action of the Sorbact portfolio of dressings of resolving infections by removing wound bacteria is beneficial for all types of wounds. The physical binding of microorganisms by these DACC-coated dressings avoid an active bactericidal action on microbes and relies instead on a physical mode of action to reduce bacterial load. This mechanism of bacterial load control makes the development of resistance unlikely. Unlike traditional antimicrobial dressings, DACC-coated dressings do not release any chemically or pharmacologically active substances but rather uses a physical mode of action using the hydrophobic interaction of DACC to reduce bacterial load.²⁸ This suggests that the use of this dressing does not adversely affect the wound bed or cells involved in the various aspects of wound healing. Sorbact dressings can be used prophylactically for wounds at risk of infection or re-infection because of their lack of damaging effect on wound-derived cells and processes. They can be used during all phases of the healing response.

Conclusion

The Sorbact portfolio of wound dressings have a unique “passive” mechanism of action that can:-

1. Reduce levels of bioburden (without the use of an “active” anti-microbial agent)

2. Enable the progression of healing in static/chronic wounds.

In acute wounds such as clean surgical wounds, Sorbact provides a reduced risk for the development of costly SSIs. The innovative approach to reducing microbial load means that they are effective against microorganisms that are resistant to antibiotics. The natural binding and removal of microorganisms prevents the release of endotoxins into the wound and no chemical agents are released into the wound, therefore Sorbact may be used prophylactically for wounds at risk of infection or re-infection and during all phases of the healing response.

These wound dressings provide an important contribution to aiding managing and preventing of wound infection in a way that will not further exacerbate the resistance problems seen with the catastrophic over-use of antibiotics that has led to multiple resistant micro-organism that threaten the very future of humanity.

Limitations

This review was not a systematic review of the literature and includes a larger number of lower quality studies than would be found in a systematic review. In randomized controlled trials, investigators can study a specific clinical question by exerting control over the treatment variable(s). Outside the control of randomized controlled studies, smaller-scale studies, case series and reports examine "real world data" which reflects the actual care received by patients in clinics and offers significant insights into the dressing's use.⁹⁸ With this in mind, our review is in general agreement with a recent systematic review of the use of DACC-coated dressings in supporting the management and prevention of wound infection.²⁷

Key points

- The Sorbact® portfolio of wound dressings have a unique mechanism of action that utilizes of dialkylcarbamoyl chloride (DACC)
- The surface of Sorbact® dressings is highly hydrophobic and in conjunction with the hydrophobic nature of bacterial cell walls mediates irreversible binding of micro-organisms to the surface of the dressings
- The Sorbact® portfolio of wound dressings have a unique "passive" mechanism of action that can a) Reduce levels of bioburden (without the use of an "active" anti-microbial agent) and b) Enable the progression of healing in static/chronic wounds

Reflective questions

- What wounds are at the greatest risk of infection?
- What are the most common types of hospital infection and how may they be defined?
- Why should the use of antibiotics to treat wound infection be managed carefully?

- What results from the use of "active" mechanisms of antibacterial agents?
- Why are physical modes of mechanisms of antibacterial action less likely to invoke a physiological response in the patient?

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Figures and Tables

Figure 1. The principle of hydrophobic interaction involved in DACC-microorganism interaction (modified from Ljungh et al.²⁸)

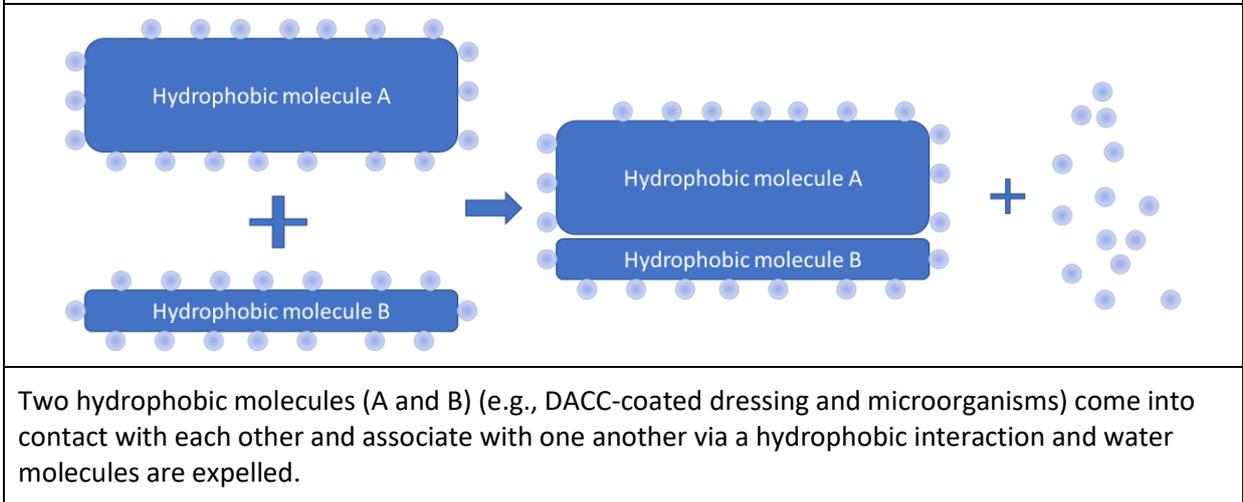


Figure 2. Cost of treatment of SSI after cesarean section (modified from Stanirowski et al.⁴²)

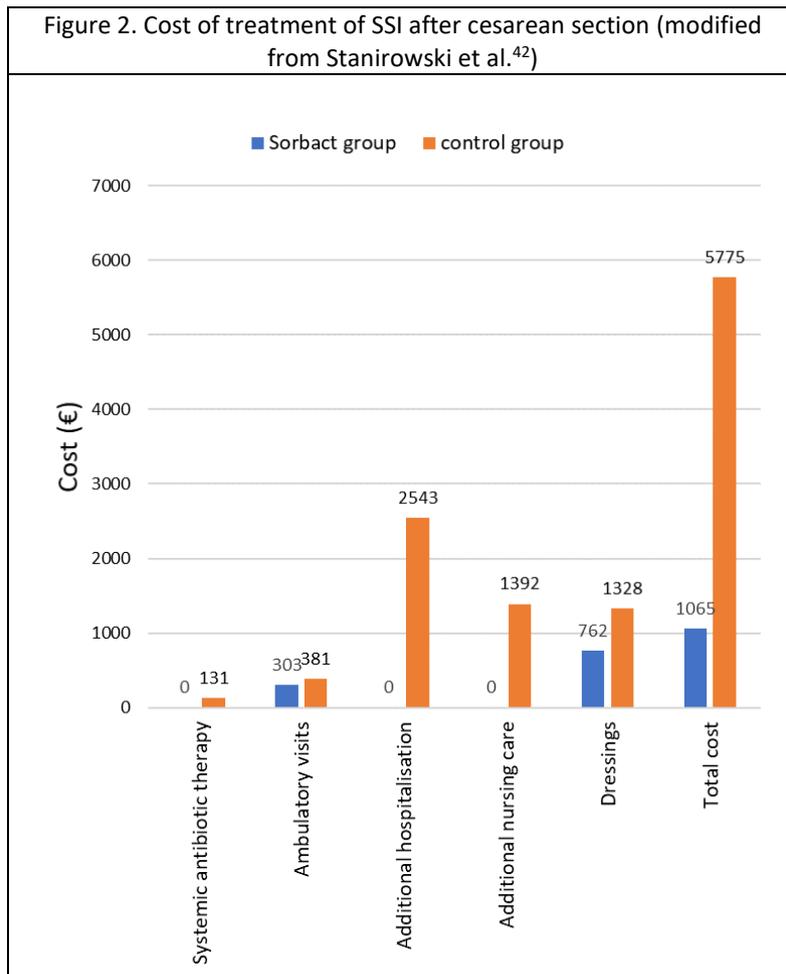


Figure 3. Comparison of bacterial loads on Day 0 and Day 4 in ulcers treated with wound dressings (modified from Mosti et al.²⁹)

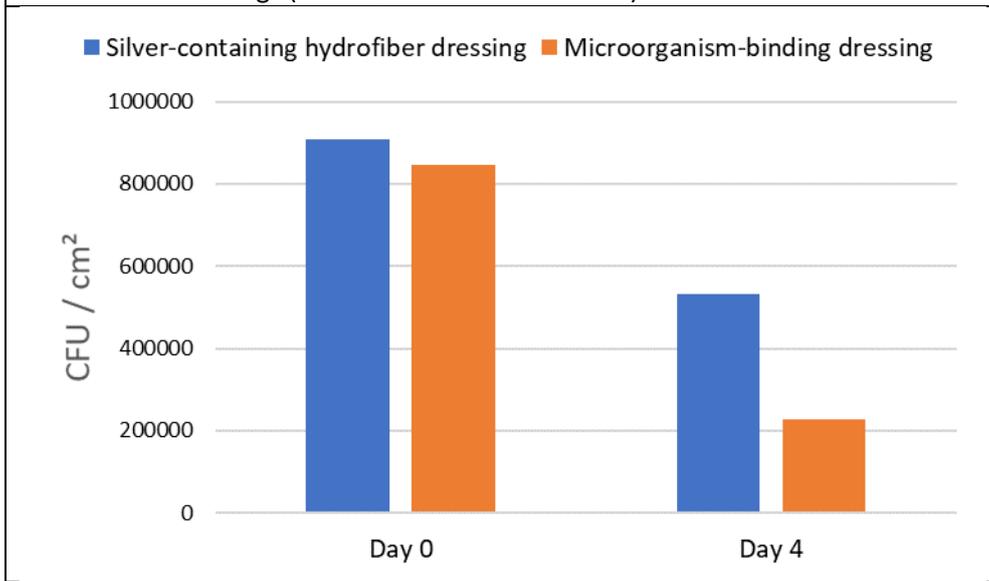


Figure 4. Percentage of wound infections at the start and end of treatment with Cutimed Sorbact (modified from Kammerlander et al.⁷³)

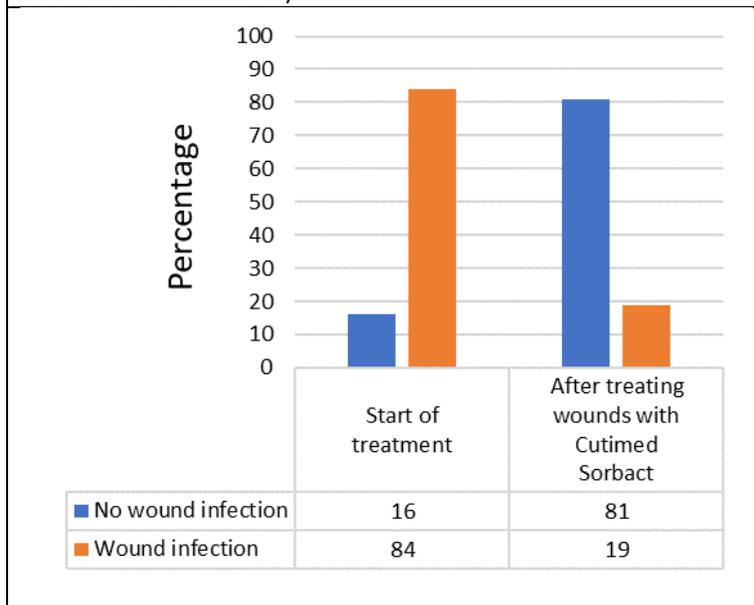
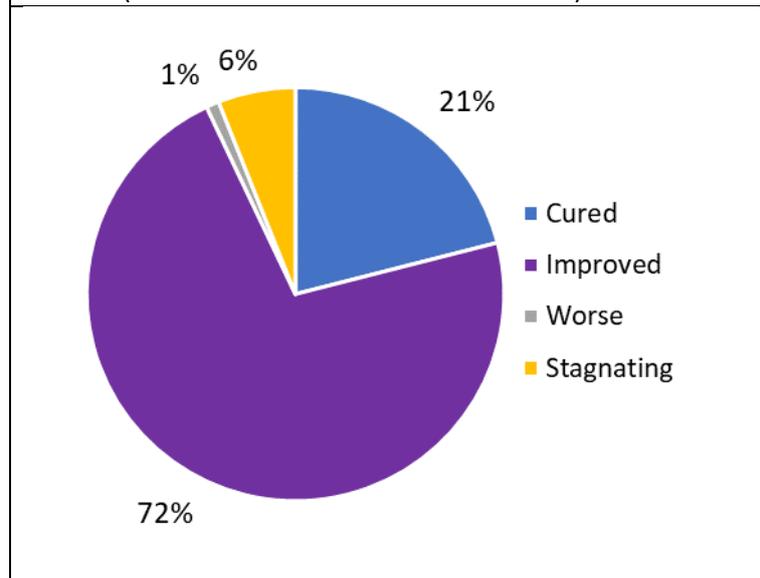


Figure 5. Wound outcomes after treatment with Cutimed Sorbact (modified from Kammerlander et al.⁷³)



Text Box 1. Surgical site infection/acute wounds/burn wounds: key points

- Cesarean surgery: 65% reduction in SSI rates with 1.8% with Cutimed Sorbact vs. 5.2% with standard surgical dressings (p=0.04)⁴²
- Vascular surgery: SSI rates lower in Leukomed Sorbact group compared with standard dressing group (1% vs. 10%, respectively, p<0.05)⁴⁵
- Skin graft: Cutimed Sorbact as effective as calcium alginates (Gold standard of care dressings) for infection prevention and enabling healing progression⁵¹
- Burn wounds: wounds cleaner when treated with Cutimed Sorbact and 27% of wounds appeared healed⁶⁸
- NPWT: exudate reduction and negative microbiology in all patients with complex infected wounds by week 2 when using Sorbact as a wound contact layer with NPWT. Wound size reduction in all patients⁶¹

Text Box 2. Non-healing/chronic wounds: key points

- Venous leg ulcers: 85% of wounds healed or reduced in size (44-92% wound area reduction) with Cutimed Sorbact. Forty-eight percent of patients had reduction in clinical signs of infection⁷¹
- Diabetic foot ulcers: reduced signs of infection in 100%, 69% of wounds showed reduced wound size and 28% or wounds had healed when treated with Cutimed Sorbact⁹⁰
- Pressure ulcers: treatment with Cutimed Sorbact resulted in improved wound bed and peri-wound skin and led to faster healing⁸³

Table 1. Key peer-reviewed clinical evidence for use of Sorbact range on acute wounds (e.g., SSIs)

Author	Study design	Aetiology	Sample size	Intervention	Outcome measures	Main findings
Stanirowski et al. ⁴³	Single-blinded randomized, controlled pilot study	Emergency or elective cesarean section surgery	n=142	Intervention – Sorbact Surgical dressing Control – standard surgical dressing	Superficial or deep SSI within 14 days after c-section	SSI rates of 2.8% in DACC-coated dressing versus 9.8% in control (p=0.08)
Stanirowski et al. ⁴²	Single-blinded randomized, controlled study	Emergency or elective cesarean surgery	n=543	Intervention – Sorbact Surgical dressing Control – standard surgical dressing	Superficial or deep SSI within 14 days after c-section Cost-effectiveness of dressing to prevent SSI	SSI rates of 1.8% with DACC-coated dressing versus 5.2% in control (p=0.04) Total cost of SSI prophylaxis and treatments was greater in SSD group compared with DACC group Only in DACC group was there no use of systemic antibiotic treatment or hospital readmission
Bua et al. ⁴⁵	Prospective, non-randomised	Non-implant vascular surgery	n=200	Intervention – DACC-coated postoperative dressing Control – standard/conventional	Primary outcome – presence of SSI Secondary outcome	Rate of SSI at 5 days was significantly lower in the DACC group compared with

	comparative study			dressing	included evidence of healing	standard dressings (1% vs. 10%, P < 0.05) There was no difference in the rates of SSI at 30 days
Choi et al. ⁵⁰	Case series	Skin grafting on clean surgical wounds	n=7	Skin graft dressed with DACC-coated dressing	Wound infection	No wounds became infected
McBride et al. ⁵¹	Prospective, randomized controlled study	Clean donor site wounds	n=101	Intervention – Sorbact Comparator – calcium alginate dressing or ointment-impregnated gauze	Primary outcome – days to re-epithelialisation Secondary outcome – includes cost and pain management	Sorbact as effective as calcium alginate dressing regarding re-epithelialisation, pain management and cost
Meberg & Schøyen ⁵⁷	Prospective randomized controlled study	Umbilical cord stump wounds	n=2441	Intervention – Cutimed Sorbact Control – daily cleansing with 0.5% chlorhexidine in 70% ethanol	Infection in the newborn	No significant difference in either overall rate of infection
Bateman ⁶¹	Non-comparative evaluation	Various infected wounds including DFU, SSI	n=10	Use of DACC-coated dressing as wound contact layer with NPWT	Wound size and characteristics	Exudate reduction and negative microbiology in all patients by week 2. Wound size reduced for all patients
Bateman ⁶⁹	Non-comparative evaluation	Surgical site infection wounds	n=3	Use of DACC-coated dressing as wound contact layer with NPWT	Wound size and characteristics	All 3 patient's wounds progressed by week 2, with no evidence of slough, malodour or necrosis
Bullough et al. ¹⁰⁰	Non-comparative evaluation	Infected abdominal wounds	n=4	Cutimed Sorbact used instead of NPWT on infected wounds	Wound infection	All signs of wound infection had resolved by day 14 of treatment. Three of the four wounds healed
Jeffrey ⁶⁰	Case series	Various surgical wounds	N=7	Cutimed Sorbact used as wound contact layer with NPWT	Wound improvement and quality of life benefits	Wound improvement with complete wound healing in several wounds

Table 2. Key peer-reviewed clinical evidence for use of Sorbact range on non-healing wounds						
Author	Study design	Aetiology	Sample size	Intervention	Outcome measures	Main findings
Brambilla et al. ⁷¹	Multicentre case study series	VLUs	n=63	Where signs of infection were present Cutimed Sorbact was used under compression bandaging	Healing and wound size	Reduction in wound size or complete healing in 85% of cases Improved QoL
Gentili et al. ⁷²	Non-comparative, double-blind study	Chronic arterial ulcers, VLUs	n=19	Wounds treated with Cutimed Sorbact for 4 weeks	Wound healing and size; bacterial load	Positive clinical outcomes in 75% of cases and marked decrease in bacterial load in 50% of cases 66% of wounds reduced in size
Mosti et al. ²⁹	Randomised, comparative, single centre study	Critically colonised or infected chronic leg ulcers	n=40	Intervention – Cutimed Sorbact Comparator – silver-containing hydrofiber	Reduction in bacterial load	After 4 days, average bacterial load reduction 73.1% in Cutimed Sorbact compared with 41.6% reduction in comparator (p<0.05)
Kammerlander et al. ⁷³	Non-randomised, multi-centre evaluation	Various wound types including VLUs, DFUs, post-operative wounds	n=116	Wounds treated with Cutimed Sorbact as part of therapeutic regimen	Inflammation; local infection; healing; tolerability; compatibility with other products; ease of product handling	Cutimed Sorbact improved 72% of wounds; 21% healed completely. Of infected wounds, 81% healed and 93% saw an improvement 81% of wounds were successfully treated for infection. 21% of wounds healed completely
Hampton ⁹²	Observational study	Various non-healing wounds including pressure ulcers, VLUs, surgical wounds	n=21	Wounds treated with Cutimed Sorbact range	Reduced bioburden, inflammation, exudate levels, malodour, wound size, pain	Healing progression in 95% of wounds; 29% of wounds healed after 4 weeks
Sibbald et al. ³¹	Non-comparative clinical evaluation	DFUs, VLUs	n=16	Wounds treated with Cutimed Sorbact	Resolution of superficial and deep infection; healing	Improved healing in 71% of patients; no significant difference in infection
Mussi and Salvioli ⁸³	Case-controlled study	Infected pressure ulcers	n=33	Intervention – specific guidelines for infected pressure ulcers with Cutimed Sorbact substituted for usual dressing Control – specific guidelines	Wound bed colour; oedema and erythema; effect on debridement; healing time	Sorbact improved wound bed colour, oedema and erythema, aided debridement and resulted in faster healing time
Haycocks and Chadwick ⁹⁰	Non-randomised single-centre open case series	DFUs	n=19	Wounds treated with DACC-coated dressing as a wound contact layer	Wound size; pain; signs, symptoms, risk of infection; maceration; malodour; healing; ease of use	By study end, all 29 wounds had reduced signs of infection. 69% of wounds had reduced in size and 27.6% of wounds had healed
Kleintjes et al. ⁶⁷	Prospective, randomized pilot study	Partial- or full-thickness burn wounds	n=13	Intervention – Cutimed Sorbact Comparators – nanocrystalline silver dressing and silver dressing	Wound status (wound colour, epithelialisation, healing); bacterial load	Wound areas dressed with DACC-coated dressing subjectively cleaner and had less bacterial growth
Kleintjes et al. ⁶⁸	Prospective descriptive study	Partial-thickness burns	n=27	Wounds treated with Cutimed Sorbact	Wound appearance; wound size	Most wounds appeared clean and pink 27% of wounds appeared healed