Ensuring that the correct antimicrobial dressing is selected


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This article examines the various tools available to clinicians in the fight against the increase of antiobiotic resistance in bacteria and the environmental hazards associated with antibiotics. The importance of employing an effective wound assessment during diagnosis is emphasised, while the selection of antiseptic dressings should always be based on an assessment of the microbial burden in the wound, the wound type and the location and condition of the wound.

INTRODUCTION

The skin is the largest organ in the body. It has multiple functions including acting as a passive barrier against foreign substances, bacteria and irradiation. It also acts as a dynamic barrier through thermoregulation, the exchange of gases and immune surveillance. When skin failure occurs, these functions are compromised.

All open wounds contain microorganisms, yet the majority are not infected. Wound infection depends on the number of invading organisms present, their virulence and the ability of the host to manage the bacterial load. The spectrum of interactions between the microbial community are shown in *Table 1*[1]. The host may gradually reach a point at which wound healing is impaired. At this point, immediate intervention to pre-empt infection is required[2].

Bacterial biofilms are now considered to be one of the key contributors to chronic wound pathogenesis and 'hard to heal' recalcitrance, alongside hypoxia, ischaemia-reperfusion injury and intrinsic host factors[3,4]. Biofilm development involves a cycle of attachment — growth involving persister cells and the detachment of planktonic phenotypes. The rate of biofilm formation in chronic wounds can be rapid and the prevalence of biofilms in chronic wounds can be high[5]. In one study, 30 out of 50 chronic wounds were reported to contain biofilms[6].

Biofilms are regarded as non-visible to the naked eye. However, Wolcott et al[5] described visible signs of macroscopic manifestations — translucent or opaque gel-like material — that were responsive only to selective treatments[7]. This has not been proven by confirmatory molecular techniques, such as polymerase chain reaction (PCR), confocal or scanning electron microscope (SEM) microscopy, and an accurate diagnostic is eagerly awaited.

Any factor that impairs the ability of the host to mount a response to bacteria in an open wound increases the risk of infection. These factors may include co-morbid conditions, such as obesity, renal failure, diabetes, collagen, vascular disorders, malignancy and anaemia. Medications that suppress immune function such as corticosteroids and chemotherapeutic agents also increase the risk of infection.

Poor tissue perfusion is a key risk factor for infection. Wound-related factors may include the presence of necrotic tissue or a foreign body, prolonged duration, large size or depth and anatomical location. Patient factors, such as poor hygiene and treatment choices, must also be considered. Tasks that are inadequately performed by carers, such as poor hand hygiene or dressing techniques, may put the patient at risk. The clinician must consider all of these factors and develop strategies to mitigate them in order to reduce the risk of infection.

RECOGNISING AN INFECTED WOUND

The diagnosis of wound infection is primarily

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Table 1: Bacterial burden in chronic wounds

Term	Clinical interpretation	Clinical intervention
Contaminated	*Bacteria on surface only. No signs or symptoms*	*Monitoring and risk reduction*
Colonised	*Bacteria attached to surface, starting to form colonies, minimally invasive. No local tissue damage*	*Monitoring and risk reduction*
Localised infection (also called critical colonisation or occult Infection)	*Bacteria more deeply invasive. Local wound bed involved. Healing compromised in healable wounds. Subtle signs of infection may be present including:* ■ **Friable bright red granulation tissue** ■ **Increased or altered exudate** ■ **Increased odour** ■ **Increased pain** ■ **Localised oedema**	*Intervention required. Often can be managed with local measures such as topical antimicrobials or antimicrobial dressings in addition to effective debridement*
Spreading infection	*Bacteria now involve the surrounding tissues. In addition to the subtle signs described above classic signs of infection such as pain redness, heat and swelling may be present. Other signs and symptoms include:* ■ **Wound breakdown with satellite lesions** ■ **Induration and redness extending well beyond the wound borders** ■ **Lymphangitis** ■ **General malaise**	*Intervention required as for localised infection plus systemic antibiotics*
Systemic infection	*Classic signs of sepsis including pyrexia or hypothermia, tachycardia, tachypnoea, elevated or depressed white cell counts and in more severe cases multi-organ system failure*	*Intervention required as for spreading infection. Other sources of infection need to be ruled out. Systemic and topical measures required*

clinical. The assessment should include evaluation of host factors, the surrounding skin and the characteristics of the wound itself. Wound swabs, while helpful in directing treatment, do not in themselves diagnose infection. While there are no validated tools to assess for wound infection, a bioburden simple checklist based on the international consensus document may be helpful in deciding on the level of bacterial burden in a chronic wound[1,8,9,10]. At each assessment, the clinician checks the appropriate boxes if the signs or symptoms are present and leaves them blank if they are absent. (See *Tables 2 and 3* for the checklist and its interpretation.)

TECHNIQUES FOR DISRUPTING INFECTION

Clinical interventions are described for various levels of bacterial burden in wounds [*Table 1*]. Localised wound bioburden is managed through good cleansing, effective debridement and judicious use of antimicrobial dressings. For more deeply invasive infections or sepsis, systemic antibiotics are also required in addition to local measures. Recently, discussion has focused on disrupting biofilms. To date, the most effective intervention appears to be the 'clean and cover' approach, using effective debridement followed by application of an

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antiseptic/antimicrobial dressing to prevent the biofilm from reoccurring.

Cleansing

Some issues have focused on which cleansing agents are appropriate. Only minor and contradictory differences in the related prevalence of infections between tap water and saline cleansing have been reported[11]. Antiseptic cleansers were at one time considered toxic and

Table 2: Bioburden checklist

Group	*Signs and symptoms*	*Date (year/month/day)*					
A	■ **Stalled healing**						
	■ **Friable and bright red granulation tissue**						
	■ **Increasing or altered exudate**						
	■ **Increasing malodour**						
	■ **Localised oedema**						
	■ **Increased pain**						
B	■ **Increasing induration plus erythema extending well beyond wound borders**						
	■ **Wound breakdown and/or satellite areas of breakdown**						
	■ **Lymphangitis**						
	■ **General malaise**						
C	■ **Fever**						
	■ **Rigors**						
	■ **Chills**						
	■ **Hypotension**						
	■ **Organ failure**						
Category: I, II, III, IV							
Clinician initial							

Table 3: Clinical interpretation of bioburden checklist

Level of risk	*Category*	*Definition*
Colonised: at risk	*I*	*No signs or symptoms from any group. Clinical decision based on location of wound and co-morbid conditions*
Localised infection (Critically colonised)	*II*	*Presence of two or more signs or symptoms from Group A (See Table 2)*
Spreading infection	*III*	*Presence of two or more signs or symptoms from Group A PLUS one or more from Group B*
Systemic infection	*IV*	*Presence of any sign or symptom from Groups A and B PLUS one or more from Group C*

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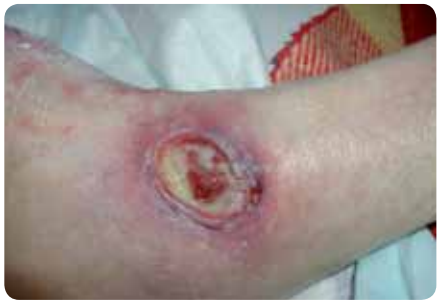
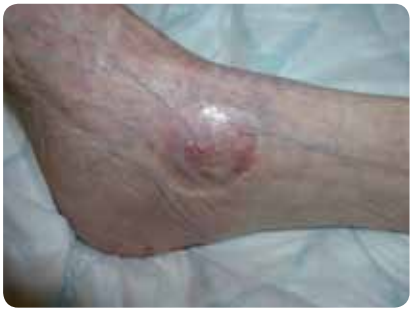
Table 4: Antimicrobial dressings

Antimicrobial agent	Dressing forms	Comments
Medicated tulles	*Petrolatum gauze or other non adherent vehicles impregnated with:* ■ Antibiotics such as framycetin, fucidic acid or bacitracin zinc ■ Antiseptics such as chlorhexidene or iodine	■ Bacterial resistance may develop to antibiotics ■ Antibiotics may cause irritation or allergy ■ Antiseptic preparations preferred
Silver dressings	*Vehicles may include:* ■ Alginates ■ Foams ■ Hydrophilic fibres ■ Gels ■ Powders ■ Impregnated gauze ■ Combined with oxidised regenerated cellulose/collagen ■ Combined with collagen ■ Coated polyethylene mesh ■ Impregnated hydrocolloids ■ Combined with charcoal in a sachet	■ Silver may be atomic, oxysalt or ionic form ■ Broad spectrum of activity against bacteria ■ Debate about effectiveness of high vs. low release formulations ■ Some formulations kill bacteria within dressing ■ May reduce inflammation through reduction in matrix metalloproteinases (MMPs) ■ May be useful against biofilms in the 'debride and cover' strategy ■ Charcoal containing preparation may be useful in odour control ■ Choose vehicle depending on other wound characteristics
Iodine	*Three preparations:* ■ Iodophor-impregnated gauze ■ Slow release molecular iodine in cadexomer starch beads ■ Povidone iodine-impregnated non-adherent dressing	■ Broad spectrum activity against gram negative, gram positive, anaerobes, viruses and fungi ■ Some evidence of effectiveness of the cadexomer form against biofilms but all may be useful in the 'debride-and-cover' strategy ■ Cadexomer starch absorbs wound fluid (6x weight) ■ Care with large amounts over long periods due to possible thyroid interaction
Polyhexamethyline biguanide (PHMB) or polyhexanide	*Multiple preparations:* ■ Ribbon gauze ■ Gauze squares ■ Transfer foam ■ Backed foam ■ Non-adherent ■ Gels	■ Broad spectrum of activity ■ Bacterial kill largely in dressing ■ Choose vehicle based on wound characteristics ■ Ribbon gauzes are particularly useful for sinuses
Hypertonic saline	*Hypertonic saline in:* ■ Gauze ■ Gel	■ Help to debride necrotic tissue ■ Help to control bacterial loads ■ May be painful
Honey	*Leptospermum honey in:* ■ Liquid form ■ Alginate pads ■ Hydrocolloids	■ Biocidal effect is multifactorial ■ May assist with autolytic debridement ■ Choose formulation based on wound characteristics





Clockwise from top left: Figure 1 shows rapid debridement/cleansing effect in a pressure ulcer with wound cleansing and wound dressing containing PHMB. Figure 2 shows the healed wound after treatment. Figure 3 depicts modern debridement with Debrisoft moisturised with Prontosan. Slough and debris is 'sucked' into the monofilaments.

Credit: Eva Robertsson and Christina Lindholm

were contraindicated. However, recent research examining the presence of biofilms in wounds, suggests the use of more effective cleansing methods are needed[12].

Antiseptic wound cleansing agents, which are able to disrupt biofilms, have become increasingly used in clinical practice. One such wound cleanser is Prontosan® (B Braun), available both as a irrigation solution and as a gel in different viscosities. It contains betaine — a surfactant — which helps in breaking up the biofilm[13] and polyhexanide, which is reported to disrupt biofilms. Clinical experiences of this agent in heavily colonised/locally infected wounds are reported to be good. However, without repeated debridement, a biofilm often rapidly reforms[6]. Other common antiseptic cleansing agents include sodium hypochlorite solutions, chlorhexidene, dilute acetic acid and povidone iodine[14]. Their use remains controversial — in some areas, they are banned from use, while in others, they are considered standard care. In resource-poor settings they may represent the only available means of managing bioburden in chronic wounds.

Debridement

Traditional techniques for debridement have included supporting autolytic debridement through dressing choices, enzymatic debridement using exogenous collagenase applied to the wound, conservative sharp debridement using surgical instruments to remove non-viable tissue or more aggressive surgical debridement *[Figs 1–3]*. There are other options used for debridement, including hydrosurgery and ultrasound. These are expensive to use and require specific skills. Mechanical debridement with saline wet-to-dry dressings is not considered an effective debridement modality but irrigation with safe irrigating fluids can be used. In some settings, maggots are to used to reduce debris and bacterial burden[15,16].The effect is greater in the removal of gram-positive bacteria, compared with gram-negative species[2].

More recently, dressings that actively debride the wound have become available. These work by actively sequestering exudate, bacteria, debris and inflammatory cytokines within the dressing. One such product for gentle and effective debridement is Debrisoft® (Activa). This product contains 18 million monofilaments. After moisturisation, it can be carefully wiped/stroked over the wound, 'sucking' debris, probably biofilm products and bacteria, into the monofilaments[16]. Similar products include Drawtex® (Beier Drawtex Healthcare) and Sorbion Sachet® (Sorbion).

Antimicrobial dressings

Following thorough wound cleansing and debridement, appropriate wound dressings should be selected. The selection of such dressings is dependent on wounds status and the treatment goals for the patient *[Table 4]*.

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When a wound is assessed as critically colonised or locally infected, dressings containing topical antiseptics should be selected. The selection of such a dressing is dependent on the wound condition, exudate level, adaptability of the dressing to suit the wound, patient comfort, associated pain and the treatment goals for the respective wound and the patient. There is little advice to be obtained from systematic reviews regarding choice of topical antimicrobials, and most practice has to be based on the results of research, which has been performed *in vitro*.

The specificity and efficacy of the agent, its cytotoxicity to human cells, its potential to select resistant strains and its allergenicity must be considered[1]. Modern topical antiseptics include polyhexanide (PHMB)[13, 18], silver[19, 20], iodine[21] and honey[22, 23]. A product range with hydrophobic technology, the Cutimed Sorbact® (BSN medical) product series, has been developed, where the microorganisms adhere to the dressing by hydrophobic interaction. These dressings do not contain any antiseptic agent[24]. *Table 4* provides a general overview of some of the common, generic antimicrobial dressings available. These may have different trade names and are not universally available.

NPWT

It is beyond the scope for this paper to review negative pressure wound therapy (NPWT) in critically colonised/infected wounds. However, new techniques and devices have been developed which facilitate effective reduction of wound exudate and bacteria in many types of wounds. Some are also applicable for minor wounds, like PICO® (Smith & Nephew)[25], whereas others, such as V.A.C.Ulta™ (KCI) can be used together with an irrigation solution such as Prontosan. NPWT has become a major treatment option for some infected wounds.

CASE STUDY

A 55-year-old man with a normal ankle brachial pressure index and a previous ankle fracture presented with a venous stasis ulcer of one year's duration. A complete medical history demonstrated no co-morbid conditions or medications that would affect healing. The patient had been self-treating the recurrent ulcer. Compression therapy is the cornerstone of treatment for venous ulcers, therefore, no progress could be made with the patient's ulcer until compression therapy was initiated.

However, the patient-centered concerns had to be addressed first. Since the patient had been treating the ulcer by himself for a year, it was evident that he was reluctant to seek treatment from medical professionals. His psychosocial issues had to be addressed, not the least of which was pain. It became necessary to convince him that if the swelling in his leg reduced, the pain would reduce as well. Every part of treatment had to be fully explained in order to convince him of what needed to be done.

There was non-viable tissue in the wound bed, so the ulcer was debrided with a method that did not increase pain. The size and duration of the ulcer, the friable wound bed and the stalled healing were consistent with localised infection. Maceration was visible, indicating that the wound was highly exudating. The wound was cleansed with a irrigation solution, covered with a PHMB-based foam and compression therapy initiated. The wound closed within eight weeks.

CONCLUSION

Selection of antimicrobial/antiseptic dressings should always be based on an assessment of the microbial burden in the wound, the host defence of the patient, the type of wound and the location and condition of the wound.

Modern antiseptics for wound management have proven to be safe and efficient, and should not be confused with old, cytotoxic preparations. Wounds in children, major wounds and some patients´ specific sensitivities to components in the antiseptic require consideration when selecting topical antiseptics. Both the overuse and misuse of topical antiseptics might theoretically lead to development of bacterial resistance against the specific substance in the future, although this is unlikely based on the non-specific action of microorganisms. However, in the face of the global threat of increasing antibiotic resistance and environmental hazards associated with antibiotics, the prevention and treatment of critically colonised/locally infected wounds with topical antiseptics, such as PHMB, povidone iodine, silver, honey and similar products is an attractive option.

AUTHOR DETAILS

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