Wound bed preparation

Necrotic, non-viable tissue provides a focus for infection, exacerbates the inflammatory response and impedes wound healing.[12] This includes foreign material (wound dressing remnants, multiple organism-related biofilm or slough, exudate and debris) on the wound bed. The principles of wound bed preparation are the entrenched concepts, which also include the acronyms TIME (Tissue; Infection/Inflammation; Moisture; Edge)[23, 96] and Biofilm-based Wound Care (BBWC).[97] These principles promote maintenance of a healthy wound bed through therapeutic wound cleansing, disruption of biofilm and removal of necrotic, non-viable tissue through wound debridement.

DEBRIDEMENT

To stimulate wound healing and manage bioburden there are a number of methods of debridement (see Table 5). It has been demonstrated that debridement provides a window of opportunity in which the biofilm defences are temporarily interrupted, allowing increased efficacy of topical and systemic management strategies.[13] Further research is required to establish the optimal frequency of debridement; however, expert opinion suggests that debridement should be performed at least weekly. To disrupt biofilm attachment and prevent dispersal, use a combination of debridement strategies together with therapeutic cleansing with topical antiseptics and application of antimicrobial wound therapy dressings.[12, 98] New, effective biofilm disruptors that do not contain antiseptic may offer an alternative to antiseptic-containing therapies.

Table 5: Types of debridement

Type of debridement	Method	Effect on biofilm
Surgical	Performed in the operating room using scalpel and scissors[91, 99]	■ Disrupts biofilm and removes foci of infection[99] ■ If all tissue is removed, deeper biofilm can be disrupted[99]
Conservative/sharp	Performed using aseptic technique with sterile curette, scalpel and scissors[91, 99]	Removes and disrupts superficial biofilm[99]
Autolytic	Selective, slow debridement that occurs naturally and can be aided by using topical agents and contemporary wound dressings, including:[91, 99] ■ Cadexomer iodine ■ Honey ■ Fibre gelling wound dressings ■ Polyhexamethylene biguanide (PHMB)	Varying efficacy on biofilm depending on the product and the phase of the biofilm cycle in which it is applied[99]
Mechanical	Non-selective debridement performed using:[99] ■ Therapeutic irrigation (4 to 15 psi) ■ Monofilament fibre pads ■ Low-frequency ultrasound ■ Hydrosurgery	Some levels of disruption and removal of biofilm[99]
Enzymatic/ chemical/surfactant	Application of exogenous enzymes or chemicals to the wound surface, including:[99] ■ Alginogel ■ Enzymatic debriders ■ Wound cleaners and gels with high or low concentrations of surfactant	Some levels of disruption and removal of biofilm[99, 106]
Biosurgical/ larval therapy	Sterile fly larvae that produce a mixture of proteolytic enzymes[91, 100, 101]	Good evidence of removal of biofilm *in vitro*[100, 101]

The impact of the different types of debridement on biofilm is dependent upon its stage in the life cycle. Clinicians should be aware of the efficacy of different debridement strategies and therapeutic topical agents on biofilm prevention, maturation and dispersal. When performing wound debridement, they should always work within the scope of practice, and local policy and procedures.

CLEANSING INFECTED WOUNDS

Infected wounds should be cleansed thoroughly at each wound dressing change. There is a difference between rinsing a wound and cleansing a wound. Therapeutic wound cleansing exhibits the following characteristics:[23]

- Application of a cleansing solution that has potential to disrupt biofilm and kill planktonic bacteria and other organisms (Table 6 outlines the efficacy of various cleansing solutions)
- Promotion of safety of the wound and the individual
- Availability in a variety of settings (hospital, clinic and home environment)
- Irrigation that is performed at an appropriate pound per square inch pressure
- The periwound being maintained and protected from maceration.

Stop anointing wounds and start cleansing wounds

The ideal cleansing agent and the optimal method of wound cleansing has not been established conclusively. There may be a role for judicious irrigation with an antiseptic solution (see Topical Antimicrobial Therapy).

Surfactants lower the surface tension between the wound bed and the liquid (or between two liquids), thereby promoting spread of the liquid across the wound bed and facilitating separation of loose, non-viable tissue. This characteristic has been capitalised on in the development of several surfactants that are combined with antimicrobials (e.g. polyhexamethylene biguanide [PMHB] and undecylenamidopropyl betaine; octenidine dihydrochloride and phenoxyethanol; and octenidine and ethylhethylglycerin).[23] The use of these surfactant-containing antimicrobial cleansers or antimicrobial preservative-containing cleansers is useful for disrupting biofilm in the wound.[102, 106]

There are also newer cleansing agents that are super-oxidised and/or have lower concentrations of hypochlorous acid and sodium hypochlorite compared with traditional highly toxic preparations that are no longer recommended. These newer solutions are purported to disrupt biofilm and kill planktonic bacteria and other organisms while being safe for the wound and the individual.[103, 104]

APPLICATION TO PRACTICE

Prompt diagnosis and treatment of infection promotes wound healing and minimises the impact on the individual, their carer and healthcare systems. Treatment of an infected wound should follow a clear and decisive treatment plan.

Management of comorbidities requires a multidisciplinary team approach. Thorough wound hygiene technique and wound debridement will facilitate eradication of microbes, either planktonic or biofilm. In the absence of systemic signs of wound infection, local treatment with antiseptics, surfactants (in gel or solution form) and antimicrobial dressings may be sufficient.

Post-debridement, topical antimicrobials have been recommended in order to prevent (or at least delay) attachment of planktonic microbes and to kill any disrupted or dispersed biofilm. Table 7 provides a summary of topical options for wound infection.

Regular reassessment of the individual, their wounds and the management plan is essential

Table 6: Cleansing solutions and gels				
Solution	**Type**	**Cytotoxicity**	**Effect on biofilm**	**Comments**
Sterile normal saline	Isotonic[105]	None	None	■ Sterile, non-antiseptic solution[103]
Sterile water	Hypotonic	None	None	■ Sterile, non-antiseptic solution[103]
Potable tap water	Varies in content	Unknown/variable	None	■ Not sterile[103]
Polyhexa-methylene biguanide (PHMB)	Surfactant antimicrobial	Low to none[23]	Surfactant qualities disrupt biofilm attachments[23, 106]	■ Available in gel and irrigation preparations that can be used together or separately ■ Lowers liquid surface tension, allowing greater spread and facilitating separation of non-viable tissue[23] ■ Does not promote bacterial resistance[23]
Octenidine dihydrochloride (OCT)	Surfactant antimicrobial	■ *In vitro* tests show high toxicity[107] ■ Lack of absorption suggests no systemic effects[107] ■ Not shown to disrupt healing	■ Prevents formation of new biofilm for at least 3 hours[108] ■ Inhibits planktonic and bacterial biofilm growth for up to 72 hours[108]	■ Available in gel and irrigation preparations that can be used together or separately[107] ■ Lowers liquid surface tension allowing greater spread and facilitating separation of non-viable tissue[108]
Super-oxidised with hypochlorous acid (HOCL) and sodium hypochlorite (NaOCL)	Antiseptic	May vary depending on concentrations	■ Penetrates biofilm rapidly, killing formations from within[103] ■ Does not promote resistant bacteria strains[103]	■ Purported to provide desloughing and antimicrobial activity ■ Available in gel and irrigation preparations that can be used together or separately
Povidone iodine	Antiseptic	Varies depending on concetrations[108]	■ Inhibits development of new biofilm[110] ■ Eradicates young biofilm colonies[110] ■ Significantly reduces mature biofilm colonies[110]	■ Modulates redox potentials and enhances angiogenesis, thereby promoting healing[111] ■ May inhibit excess protease levels in chronic wounds[111]

Table 7: Topical wound infection therapies			
Antimicrobial agent	**Type**	**Biofilm efficacy**	**Guidance for use**
Enzyme alginogel	Alginate gel with two enzymes: ■ Lactoperoxidase ■ Glucose oxidase	■ Prevents formation of biofilms at concentration M0.5% (w/v)[112,113] ■ Inhibits growth of established biofilms at higher concentrations ■ Does not disrupt biofilm biomass[112,113]	■ Concentrations of alginate of 3% and 5% depending on level of exudate[112,113]
Iodine (povidone and cadexomer)	■ Solution ■ Impregnated wound dressings ■ Powder and paste	■ Inhibits development of new biofilm[110, 114] ■ Eradicates young biofilm colonies[110, 115] ■ Significantly reduces mature biofilm colonies[110, 114]	■ Contraindicated in individuals sensitive to iodine or with thyroid or renal disorders[110] ■ Contraindicated in those with extensive burns[110]
Honey	■ Medical grade ■ Honey impregnated dressings	■ Inhibits biofilm growth[116-118] ■ Reduces biofilm colony formation[119] ■ Inhibits quorum sensing of biofilm, thereby reducing ability to proliferate[120]	■ Select products that have been gamma irradiated[119] ■ Leptospermum species is more effective than other types[119]
Silver	■ Salts (e.g. silver sulphadiazine, silver nitrate, silver, sulphate, silver CMC) ■ Metallic, e.g. nanocrystalline, silver-coated nylon fibres ■ Impregnated wound dressings	■ Denatures existing bacterial biofilm in concentrations over 5 μg/ml120	■ Change more frequently in wounds with heavy exudate ■ Avoid in individuals with silver sensitivities[121]
Ionic silver combined ethylenediamine-tetraacetate (EDTA) and benzethonium chloride (BEC) (antibiofilm agents)	■ Carboxymethylcellulose gelling dressing impregnated with ionic silver enhanced with EDTA and BEC	■ Combines antibiofilm and antimicrobial components that work in synergy to disrupt biofilm and expose associated microorganisms to the broad-spectrum antimicrobial action of ionic silver[122] ■ Eradicates mature biofilm within 5 days[124] ■ Prevents biofilm formation[124] ■ Associated improvement in healing rates[125]	■ Change more frequently in wounds with heavy exudate ■ Avoid in individuals with sensitivities to silver, EDTA or BEC[123]
Surfactant	■ Concentrated surfactant gels with antimicrobial preservatives	■ Prevents biofilm formation[126] ■ Increases antibiotic efficacy ■ Eradicates mature biofilm	■ Can be used between and post-debridement to prevent re-establishment of biofilm ■ May require daily application for the first few days