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ACADEMY

BIOFILM, BIOBURDEN AND ANTIMICROBIALS SIMPLIFIED

This Simplified Guide is intended to give you information about the antimicrobial products available and give you answers to some questions that you may have about treating infected wounds.

All wounds contain microorganisms and microbes *(IWII, 2022).* **Their influence on a wound is complex. It is widely accepted that most non-healing/chronic wounds are colonised with microbes, although most, even non-healing/chronic wounds, can and do heal** *(Swanson et al., 2014).*

If wound healing is impaired, the patient's immune system is compromised. This balance can shift in favour of the microorganisms, which multiply and invade tissue, which can prolong wound healing and lead to infection.

LEARNING OUTCOMES

- Managing biofilm
- Managing bioburden
- Use of antimicrobials

BIOFILM

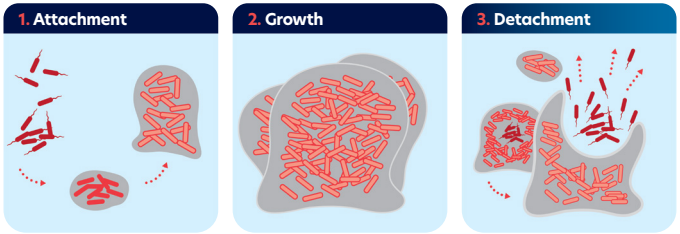
Biofilms are complex microbial communities containing fungi and bacteria. The microorganisms synthesise and secrete a protective matrix that attaches the biofilm firmly to a living or non-living surface. It is a structured community of microbes (phenotype), with genetic diversity and variable gene expression, which creates behaviours and defences used to produce unique infections (chronic infection). Biofilms are characterised by significant tolerance to antibiotics and biocides while remaining protected from host immunity *(IWII, 2022).*

The process of biofilm formation can be divided into 3 stages:

Attachment - microbes, normally free-living, move towards an area where nutrients are more concentrated and attach to the surface. This process is initially reversible but eventually becomes irreversible within the first 2-4 hours *(Bjarnsholt et al., 2017).* They reproduce to form a microcolony.

Maturation - as they mature, they start to secrete extracellular polymers *(Edward-Jones et al., 2016)* that form a protective matrix. As a result, the microbe colonies can become increasingly tolerant to biocides once the biofilm is firmly embedded in the wound *(Bjarnsholt et al., 2017).*

Dispersal - in the final step of the biofilm life cycle, single cells egress from the biofilm to resume a planktonic lifestyle. They can attach to other parts of the wound bed or migrate to other areas, forming a new biofilm.



Biofilms can exist as single species as well as a multispecies biofilm *(Edward-Jones et al., 2016).* Biofilms can be very difficult to visually identify, it can exist deep within a wound. International Consensus Update on wound infection in clinical practice (2022), outlined criteria below as indicative of a potential biofilm:

- Failure of appropriate antibiotic treatment
- Recalcitrance to appropriate antimicrobial treatment
- Recurrence of delayed healing upon cessation of antibiotic treatment
- Secondary signs of infection
- Delayed healing despite optimal wound management and health support
- Increased exudate/moisture
- Low-level chronic inflammation
- Low-level erythema
- Poor granulation/friable hyper granulation

MANAGING BIOFILM

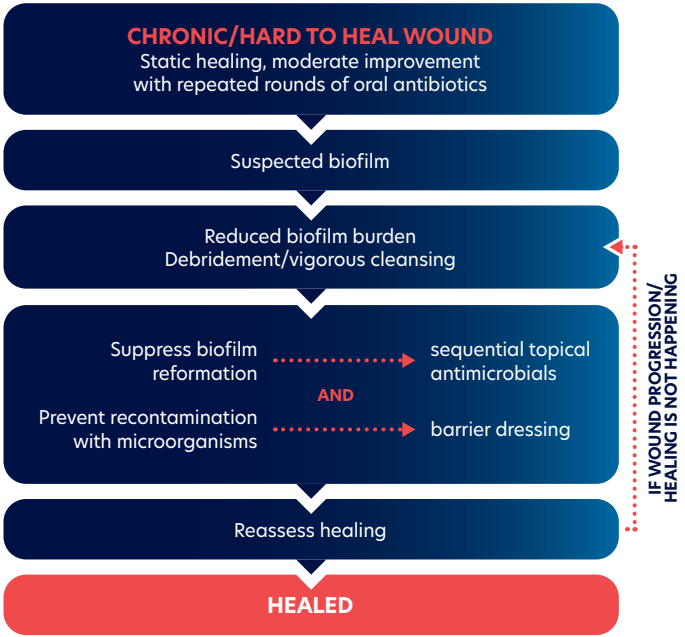
There is no one solution to dealing with a wound suspected of having a biofilm. Removing it is of clinical importance and requires a multifaceted approach, including physical removal through wound hygiene to disrupt and eliminate it. Debridement, together with therapeutic cleansing using a topical surfactant and/or antiseptic solutions, are recommended *(IWII, 2022).* Subsequent use of appropriate antimicrobial dressings will assist with managing the biofilm and infection.

The goals of therapeutic cleansing and debridement in biofilm-based:

- Remove dead/devitalised tissue, that can cause a breeding ground for infection
- Physically remove the most tolerant microorganisms from the wound bed
- Create an environment that prevents or delays biofilm reformation

(Bjarnsholt, 2017; IWII, 2022)

Following basic wound bed preparation alongside reduction and preventing reconstitution of the biofilm is a common strategy known as 'Biofilm Based Wound Care'.



Adapted from Bjarnsholt et al., 2017

BIOBURDEN

Bioburden is a degree or load of microorganisms (e.g. bacteria, virus, fungi) that creates contamination in a wound. The amount of bioburden is influenced by the quantity and virulence of microbes. If the balance of the patient's immune system is in favour of the microbes, or if wound healing is impaired, the level of bioburden will be increased.

The body's response to bacterial contamination of a wound is to elicit an inflammatory response, whereby inflammatory cells infiltrate and clean the wound in an effort to prevent infection. However, if pathogens are high, they can cause problems, initially delaying healing but eventually leading to a wound infection.

Non healing/chronic wounds are known to have a higher bioburden, and as this increases, wound healing is delayed. The normal inflammatory response intensifies with higher levels of matrix metalloproteinases (MMPs) that breaks down the extracellular matrix (ECM). The result is a prolonged inflammatory phase.

MANAGING BIOBURDEN

Evidence shows that as wounds heal, there is a reduction in the microbial load. Removal and management of any biofilm will assist in the management of the bioburden of the wound. This in turn, allows for the appropriate dressing selection dependant on the type, signs and symptoms of the wound. One of the commonest ways to reduce bioburden is to use topical antimicrobial dressings.

ANTIMICROBIALS

These are substances that act directly on a microbe in a way that will either kill the organism or significantly hinder development of new colonies. The term incorporates disinfectants, antiseptics and antibiotics. Antimicrobial therapy may be required when other methods are insufficient to manage localised wound infection, or when the infection is systemic and spreading.

Antimicrobial dressings are recommended for:

- Wounds exhibiting signs and symptoms of local wound infection and wounds suspected or confirmed as having biofilm.
- In combination with systemic antibiotics for wounds exhibiting signs and symptoms of spreading or systemic infections.

(IWII, 2022)

Antimicrobial Agent	Information	Contraindiciations
Enzyme Alginogel	▸ Alginate gel with two enzymes: lactoperoxidase and glucose oxidase ▸ Broad spectrum activity against Gram-negative and Gram-positive bacteria ▸ Low cytotoxicity	▸ Should not be used where patients have a previous sensitivity reaction to alginate dressings or to polyethylene glycol
Iodine (povidone, cadexomer)	▸ Broad spectrum activity against Gram-negative and Gram-positive bacteria, fungi, spores, protozoa and viruses ▸ Reduced selection for bacterial resistance	▸ Neonates, iodine sensitivity, thyroid and/or renal disorders ▸ Children below 12 years ▸ Pregnancy and breast feeding, ▸ Rapid release formulas may require 2-3 daily applications for optimal effect
Polyhexamethylene biguanide (PHMB)	▸ Efficacious against Gram-positive bacteria, Gram-negative bacteria, fungi and viruses ▸ Available in gel, irrigation and surfactant preparations as well as wound dressings ▸ Does not promote bacterial resistance ▸ Low cytotoxicity in vitro	▸ Known sensitivity or allergy to PHMB or components of the dressing used
Octenidine dihydro-chloride (OCT)	▸ Broad spectrum action against Gram-positive and Gram-negative bacteria, MRSA and fungi ▸ Available in gel, irrigation, and surfactant preparations ▸ Does not promote bacterial resistance	▸ Individuals who have any sensitivity or known allergic reactions to octenidine dihydro-chloride
Honey (medical grade)	▸ Effective against Gram-positive and Gram-negative bacteria including E. coli, P. aeruginosa, S. aureus, Acinetobacter, Stenotrophomonas, MRSA and vancomycin-resistant enterococci (VRE) ▸ Promotes autolytic debridement	▸ Allergy to bee venom ▸ Known sensitivity to honey ▸ Individuals with diabetes should be monitored for changes in blood-glucose concentrations during treatment with topical honey or honey-impregnated dressings
Silver (elemental-metal and nanocrystalline)	▸ Broad-spectrum activity against Gram-negative and Gram-positive bacteria, including P. aeruginosa, E. coli and S. aureus ▸ Available in a variety of wound dressings	▸ Individuals with a known sensitivity to silver ▸ Some dressings may require removing before undergoing examinations such as X-ray, ultrasound, diathermy or magnetic resonance imaging. ▸ Ulcers resulting from infection such as tuberculosis, syphilis, or deep fungal infections; third-degree burns
Silver (salts and compounds, including sulphadiazine, oxides, phosphate, sulphates and chlorides)	▸ Concentration dependent effect in eradicating mature P. aeruginosa and S. aureus biofilm ▸ Silver dressings/slow-release ions have broad-spectrum activity, including against MRSA and VRE ▸ Microbial resistance appears uncommon ▸ Available as ointment, gel and wound dressing	▸ Known allergy or sensitivity to silver ▸ Some dressings may require removing before undergoing examinations such as X-ray, ultrasound, diathermy, or magnetic resonance imaging. ▸ Silver sulfadiazine is contra-indicated in neonates, pregnancy, and individuals with significant renal or hepatic impairment, sensitivity to sulphonamides, or G6PD deficiency ▸ Ulcers resulting from infection such as tuberculosis, syphilis, or deep fungal infections; third-degree burns

Adapted from IWWI 2022; Swanson et al., 2014

ANTIMICROBIALS

The International Consensus Update 2022 recommends using a topical antiseptic for at least two weeks before evaluating its effectiveness in managing wound infection.

Treatment with antimicrobial dressings should be monitored closely. Any delay in the wound responding to the antimicrobial should be noted, and a reassessment of the wound undertaken, potentially incorporating further diagnostics, such as a wound swab, to identify alternative treatment options. Duration of use should be individualised and based on regular wound assessment.

This two-week challenge should give enough time for the antimicrobial agent to have an observable effect.

GUIDANCE ON SELECTING AN ANTIMICROBIAL TREATMENT

- Prevention in individuals at a higher risk of developing an infection
- Treatment of a local infection
- For a non-healing wound where other causes have been excluded
- Treatment of overt infection, consider using in conjunction with systemic antibiotics
- Treatment of spreading infection in conjunction with systemic antibiotics
- Efficacy in achieving clinical goals of care of the individual
- Broad spectrum and/or known efficacy for confirmed microorganisms
- Fast and long-acting activity and no or low propensity to select bacterial resistance
- Evidence showing the efficacy of the antimicrobial agent and dressing/delivery system
- Contraindications and known allergies taken into consideration
- A clear treatment and management plan with continual reassessment

(Adapted from Vowden, 2011; Wounds UL, 2020; IWII, 2022)

Antimicrobial dressings have differing active ingredients and mode of actions, they may kill or inhibit bacteria actively within the wound bed, or some dressings control bacteria passively by removing and binding the bacteria to the dressing *(Mahoney, 2015)*.

CONCLUSION

The basic steps for the prevention of biofilm are removal (clean, de-slough and debride), and prevention of reformation (use of an antimicrobial agent). Health care professionals are encouraged to implement a framework for the treatment and management of a biofilm.

REFERENCES

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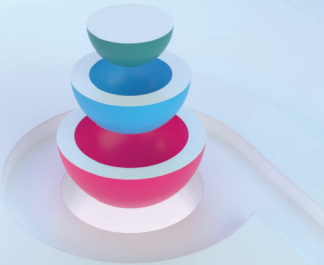
Simplifying the Complexities of Wound Care



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