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PHMB made easy

Introduction

Wound infection continues to be a challenging issue and represents a considerable healthcare burden. Therefore, managing bacterial bioburden is an essential element of effective wound care. If bacterial bioburden is not managed, the progressive states of colonisation, critical colonisation, or wound infection will follow, as outlined in the Wound Infection Continuum (Figure 1).

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There are many definitions of wound infection, but a simple definition is: impairment of wound healing by bacteria (Templeton, 2014). Infection not only affects wound healing, which has an associated impact on the patient and their quality of life, but also increases management time for the clinician and thus has practical and financial implications.

As such, infection control is a crucial element of wound care management. Recognising wound infection can be a challenge in clinical practice. The following signs of possible infection should be monitored and investigated further — i.e. a swab should be taken when these signs are observed (Patten, 2010):

- Local heat
- Redness/erythema
- Pain or tenderness
- Oedema
- Inflammation
- Increased exudate
- Cellulitis
- Abscess/pus
- Purulent discharge
- Malodour
- Delayed healing (compared with normal rate for site and condition)
- Discolouration of wound bed
- Friable granulation tissue that bleeds easily
- Pocketing/bridging at the base of the wound
- Wound breakdown/enlargement.

Vigilance and investigation is also required if:

- The patient shows signs of a systemic infection such as pyrexia, raised white cell count, blood C reactive protein levels (CRP) and/or blood erythrocyte sedimentation rate.
- The patient is elderly or immunosuppressed and therefore more susceptible to wound infections, and/or presents with other symptoms, such as drowsiness, loss of appetite, nausea, restlessness and confusion.

In recent years, antimicrobial agents have become viewed as the first line of treatment in managing bacterial burden (White et al, 2001). Antimicrobials are agents that kill micro-organisms. Antimicrobial is an 'umbrella' term that includes: disinfectants, antiseptics and antibiotics.

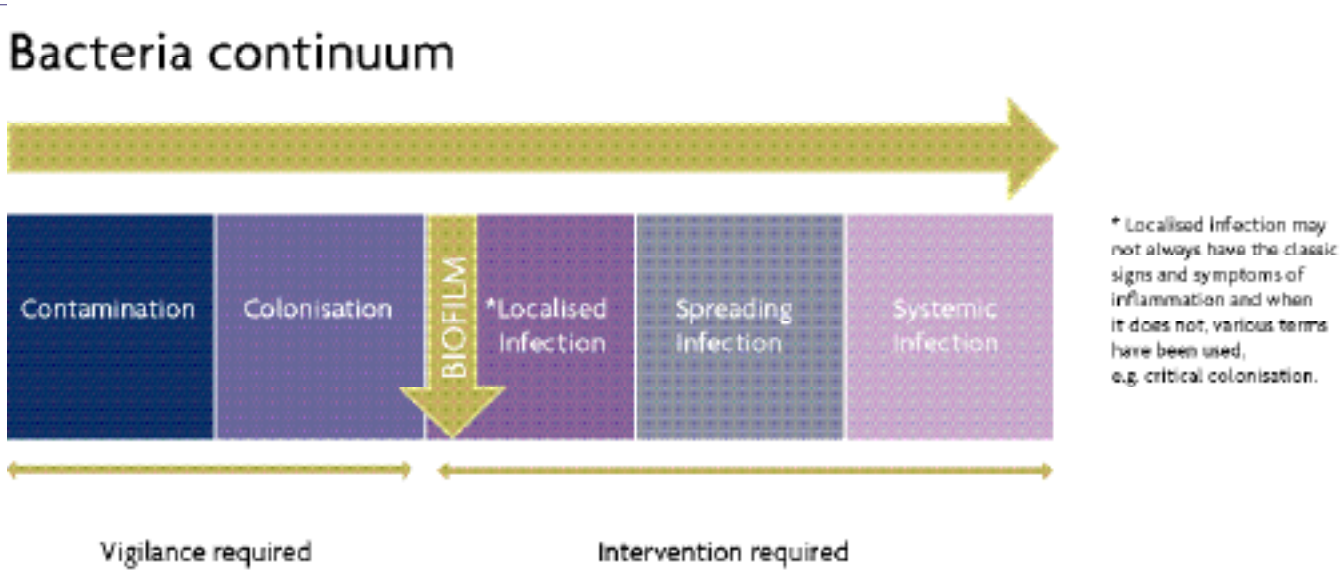

Figure 1. The Wound Infection Continuum (adapted from WUWHS, *Principles of Best Practice: Wound Infection in Clinical Practice: An International Consensus*. London: MEP Ltd, 2008)

Recent advances in antiseptic technology have led to the development of a number of products that are highly effective in destroying pathogens, while being less harmful to healthy tissue. These include antiseptics such as silver, cadexomer iodine, polyhexamethylene biguanide (PHMB) and honey; they are generally available in formulations including topical products and impregnated dressings (Table 1). These antiseptics can successfully be used in topical management to reduce the load of a variety of pathogens, not just bacteria (Vowden et al, 2011).

Type of antiseptic	Formulation
Silver	Silver sulfadiazine: cream, impregnated dressings Ionic silver: impregnated dressings Nanocrystalline silver
Iodine	Povidone iodine: solution, cream, ointment, sprays, impregnated dressings Cadexomer iodine: ointment, paste, powder, impregnated dressings
Chlorhexidine	Solution, powder, impregnated dressings Chlorhexidine may be used as an alternative for patients allergic to iodine
Polyhexamethylene biguanide (PHMB)	Solution, impregnated dressings
Honey	Amorphous honey or impregnated dressings
Acetic acid	Solution
Potassium permanganate	Solution, soluble tablets

Table 1. Antiseptic agents and their formulations (adapted from WUWHS, *Principles of Best Practice: Wound Infection in Clinical Practice: An International Consensus*, London: MEP Ltd, 2008)

All antimicrobials have different properties. The ideal antimicrobial has been described as:

- Associated with minimal systemic absorption
- Effective against likely contaminants and pathogens
- Fast-acting, with prolonged residual activity after a single dose
- Inexpensive
- Incapable of promoting bacterial resistance
- Non-carcinogenic and non-teratogenic (i.e. does not cause DNA damage, which could result in carcinoma or foetal abnormality) to host cells
- Non-toxic
- Widely available (Drosou et al, 2003).

PHMB IN MANAGING BACTERIAL BIOBURDEN

PHMB is an antiseptic agent that has a broad spectrum of action against pathogens, including Gram-positive and Gram-negative bacteria, *Staphylococcus aureus*, Methicillin Resistant *Staphylococcus aureus* (MRSA), fungi, and biofilms (Wiegand et al, 2009; Moore and Gray, 2007). See Figure 2 and Figure 3 for the performance of ActivHeal® PHMB Foam Dressing (Advanced Medical Solutions) in an *in vitro* trial (AMS, data on file).

PHMB can also be applied over a long period of time due to its low toxicity (Andriessen and Eberlein, 2008). PHMB has good tissue compatibility, strongly interacting with the acidic lipids within bacterial membranes and only weakly interacting with the neutral lipids of human cell membranes. This helps to prevent damage to the surrounding healthy tissue (Andriessen and Eberlein, 2008; Ikeda et al, 1984).

PHMB is a positively charged (cationic) polymer, which works against negatively charged micro-organisms and so can be used for the treatment of local infections. It has been proven to support wound healing in the following ways:

- Its broad-spectrum antimicrobial properties combined with its low toxicity make it ideal for managing bioburden while supporting healing (Andriessen and Eberlein, 2008).
- Its low surface tension means that it can penetrate and disrupt difficult coatings such as slough, debris and biofilms (Moore and Gray, 2007). See Box 1 for more information on identifying and managing potential biofilms.

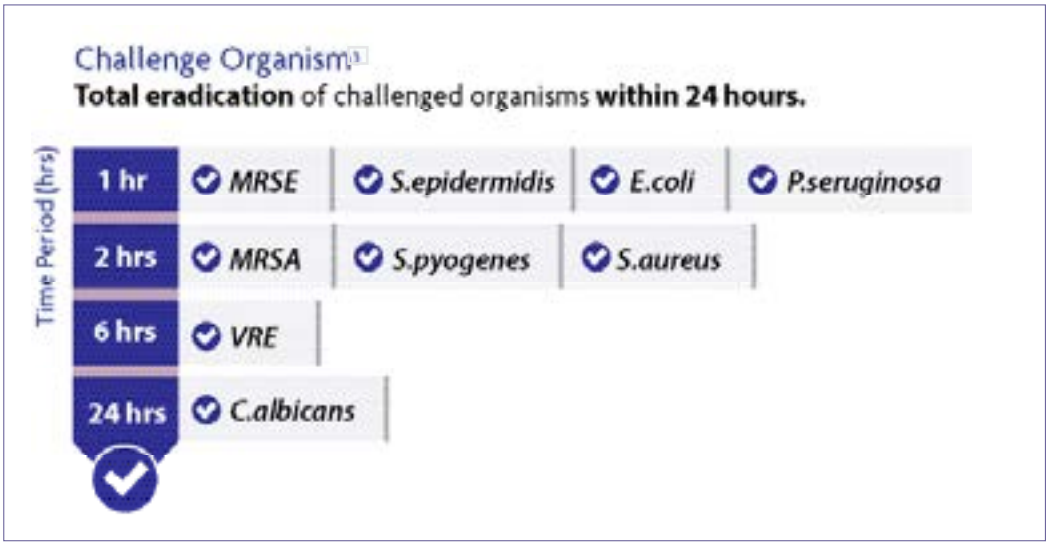

Figure 2. Eradication performance of ActivHeal® PHMB Foam Dressing on challenged organisms within 24 hours (AMS, data on file)

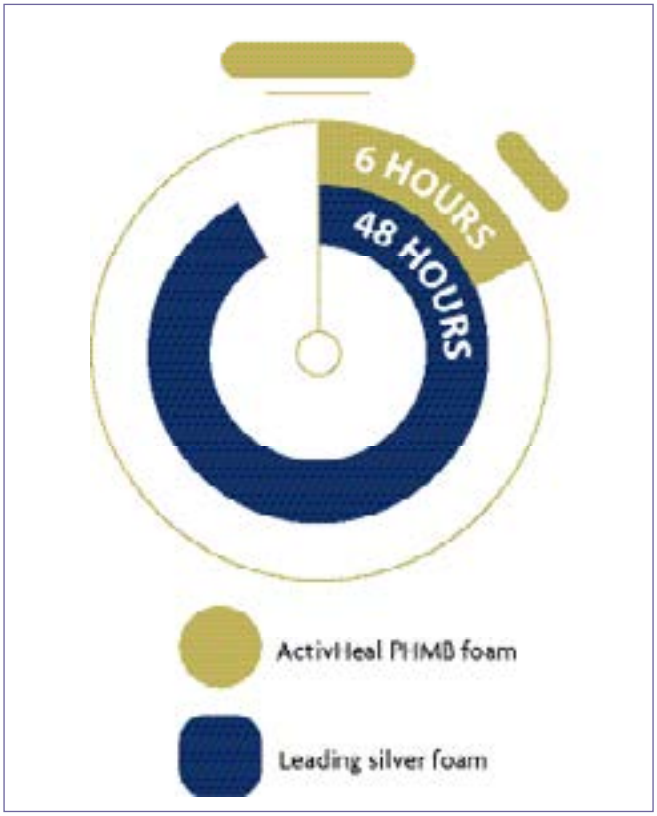

Figure 3. Comparison of log reduction time of *Pseudomonas aeruginosa* and *Staphylococcus aureus* between ActivHeal® PHMB Foam Dressing and a leading silver competitor (AMS, data on file)

Box 1: Identifying and managing biofilms (adapted from Mahoney, 2015)

Biofilms often do not display the classic signs of infection, so identifying suspected biofilms can be a clinical challenge. The following signs may indicate biofilm and should be further investigated, particularly in chronic wounds:

- Excessive exudate
- Poor-quality granulation tissue
- Signs and symptoms of local infection
- Recurring infection after antibiotic cessation
- Negative wound culture
- No healing despite optimal wound and host support
- Infection lasting >30 days
- Gelatinous material that is easily removed from the wound surface
- Surface reforms quickly.

When biofilm is identified, the following management steps should be taken:

- It has been demonstrated that frequent debridement should be undertaken to physically remove biofilm. This might be surgical, jet lavage (hydrosurgery), bio-surgical or mechanical.
- Using cleansing products containing a surfactant has been shown to disrupt biofilm production.

USING PHMB IN PRACTICE

PHMB can be effectively delivered to the wound in a number of formats, including wound rinsing solutions, gel preparations and impregnated dressings. Typically in the past, PHMB has only been available in gel and solution form; it is now available in a foam dressing format, providing an alternative mode of delivery suitable for wounds throughout the wound healing continuum. Dressings containing PHMB can act as an effective antimicrobial barrier and can reduce bacterial load within wound exudate (Wounds UK, 2010).

PHMB should be considered whenever there is a need for the safe and effective treatment of infected or critically colonised wounds, and also when chronic wounds have stopped healing or are enlarging. Chronic wounds are more at risk of complications such as infection, while infection can contribute to delayed wound healing – creating a vicious cycle (World Union of Wound Healing Societies, 2008).

Dressings impregnated with PHMB provide an effective means of infection control, while retaining the benefits of a traditional dressing (Joseph and Bhatt, 2015).

PHMB dressings can be used in wounds with varying exudate levels, in both deep and superficial wounds (Lindholm, 2010).

Examples of wound types that can be considered for treatment with PHMB dressings include:

- Second-degree burns
- Post-surgical wounds
- Traumatic wounds
- Donor/recipient sites
- Leg ulcers
- Pressure ulcers
- Epidermolysis bullosa and scleroderma wounds (Lindholm, 2010).

PHMB does not have any contraindications for application within the general wound care population. Furthermore, no known bacterial resistance to PHMB has been found (Moore and Gray, 2007).

Testing of PHMB against other commonly used antimicrobial agents has shown that it is an effective alternative to chlorhexidine, povidone-iodine, triclosan, silver and sulfadiazine; its biocompatibility (the measurement of antiseptic action in relation to its cytotoxicity) has been shown to be superior to these agents when comparatively tested (Müller and Kramer, 2008).

Evidence shows (see Box 2), that PHMB offers an opportunity to incorporate a new method of bacterial control, which has been proven safe, efficient and cost-effective.

Box 2: Summary of evidence for Polyhexamethylene Biguanide (PHMB)

In testing, PHMB has been proven to demonstrate the following benefits:

- Improving healing rates by controlling infection (Müller and Kramer, 2008)
- Encouraging the formation of healthy granulation tissue (Mueller and Krebsbach, 2008)
- Reducing wound-related pain (Daeschlein et al, 2007; Galitz et al, 2009)
- Reducing infection-associated wound malodour (Daeschlein et al, 2007)
- Reducing slough (Mueller and Krebsbach, 2008) and non-viable tissue from the wound (Kaehn, 2009)
- Reducing periwound damage (Cazzaniga et al, 2002)

SUMMARY

Overall, evidence promotes the role of PHMB in wound care as an effective antimicrobial agent. PHMB combines a broad spectrum of antimicrobial activity and an alternate option to other antimicrobials when treating patients with an infected wound, or patients who are at risk of infection. Research and testing has demonstrated that PHMB has a good safety record, and has low toxicity to human tissue and is effective in reducing bacterial load. PHMB provides benefits to both patients and clinicians by offering alternative and additional tools to manage bacterial burden within the wound care environment.

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