Reducing the number of microorganisms in chronic wounds can be challenging for health professionals, while failure to recognise their presence and take appropriate action may lead to wound infection and delayed healing (Hewish, 2014). This article discusses the latest guidance on managing the microbial burden in wounds, explains the difference between local and systemic wound infection, and provides an overview of the available antimicrobial wound products.

**What is wound infection?**

A wound is a breach in the skin’s integrity and micro-organisms will invariably develop in that breach. This is known as colonisation and is particularly common in chronic wounds, which may harbour a heavy bacterial load as a result of being open for a prolonged period (Barrett, 2017). Fig 1 shows a leg ulcer with a high bacterial load.

Generally, colonised wounds heal uneventfully (Swanson et al, 2015a), but some do not (Wounds UK, 2013). Whether or not a chronic wound harbouring a bioburden heals depends on the number of bacteria, their virulence, and whether they continue to multiply (Swanson et al, 2015a).

As wound bacteria multiply, the normal inflammatory response phase is prolonged because harmful enzymes, oxygen free radicals and inflammatory cells are released; these eventually break down tissue in the wound and cause it to deteriorate (Edwards-Jones and Flanagan, 2013). Until recently, this stage was known as critical colonisation (World Union of Wound Healing Societies, 2008).

In the past, a critically colonised wound has been defined as a wound containing <10⁵ colony-forming units (CFU)/ml bacteria (Bowler, 2003). That definition has been criticised as being simplistic, as it does not take into account the types and virulence of micro-organisms present in the wound (Swanson et al, 2015a).

The recently updated consensus guidance of the International Wound Infection Institute (2016) recommends using the broader term ‘microbial’, rather than ‘bacterial’, when discussing wound infection. It has also adopted a new way of categorising wound infection as stages in a continuum. These updated definitions and recommendations should help health professionals recognise the presence of infection in a wound and choose the appropriate management. This article presents the latest guidance and provides an overview of the available antimicrobial wound products.

**Key points**

- Updated guidance categorises wound infection as stages in a continuum and favours the term ‘microbial’ over ‘bacterial’
- In local infection, the first-line treatment is topical antimicrobial wound products
- If a biofilm is suspected, treatment should be debridement plus topical antimicrobial dressings
- Antimicrobial wound products include iodine, silver, honey and polyhexamethylene biguanide
- Antiseptic solutions should not be used routinely

**In this article...**

- Stages in the wound infection continuum
- How to recognise microbial infection in acute and chronic wounds
- Advantages and drawbacks of four common antimicrobial wound products
Acute wounds tend to be caused by a single organism, as opposed to chronic wounds, in which there may be several pathogens. Acute wounds showing signs of spreading or systemic infection should be managed with systemic antibiotics (Edwards-Jones and Flanagan, 2013).

In healthy patients with acute or surgical wounds, recognising spreading and systemic wound infection is relatively straightforward, as the signs and symptoms described in Table 1 will be apparent (IWII, 2016). A swab should only be taken if the signs of systemic infection are present, as a diagnosis of wound infection is based on the clinical assessment of both wound and patient (Swanson et al, 2015b). A wound swab should only be taken if the signs of systemic infection are present, as a diagnosis of wound infection is based on the clinical assessment of both wound and patient (Swanson et al, 2015b).

### Table 1. Stages in the wound infection continuum

<table>
<thead>
<tr>
<th>Stage</th>
<th>Definition</th>
<th>Signs and symptoms</th>
<th>Action needed</th>
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</thead>
<tbody>
<tr>
<td>Contamination</td>
<td>Presence of micro-organisms that do not multiply and do not trigger a response from the host (patient); a normal immune system will engulf and destroy them</td>
<td>Wound signs: none</td>
<td>Observation only</td>
</tr>
<tr>
<td>Colonisation</td>
<td>Presence of micro-organisms that may multiply, but at low levels; this does not trigger a response from the host and has no impact on wound healing</td>
<td>Wound signs: none</td>
<td>Observation only</td>
</tr>
</tbody>
</table>
| Local infection (formerly critical colonisation) | Presence of micro-organisms that move deeper into the wound tissue and start to reproduce rapidly; this initiates a host response. Infection is limited to one area of the wound and biofilms may be present. This will often manifest (especially in chronic wounds) as covert signs that may develop into overt signs | Covert (subtle) wound signs:  
- Evidence of hypergranulation  
- Delicate, bleeding tissue  
- Epithelial bridging and pocketing in granulation tissue  
- Wound breakdown  
- Delayed wound healing  
- New or increasing pain  
- Increasing malodour  
Overt (classic) wound signs:  
- Erythema  
- Local warmth  
- Swelling  
- Purulent discharge  
- Delayed healing  
- New or increasing pain  
- Increasing malodour | Intervention needed. Consider the use of topical antimicrobial products as first-line treatment |
| Spreading infection                         | Presence of micro-organisms that have infiltrated not only the wound, but also the surrounding tissues; these can include deep tissue, muscle, fascia, organs and body cavities | Wound and systemic signs and symptoms:  
- Increased and extended erythema  
- Lymphangitis  
- Crepitus  
- Wound breakdown/dehiscence  
- Patient feels generally unwell and/or deteriorates  
- Inflammation  
- Enlarged lymph glands | Systemic antibiotics needed |
| Systemic infection                         | Micro-organisms spreading throughout the body via the vascular and/or lymphatic systems. This affects the body as a whole | Systemic signs and symptoms:  
- Systemic inflammatory response  
- Sepsis/severe sepsis  
- Septic shock  
- Organ dysfunction/failure  
- Death | Systemic antibiotics needed |

Source: Adapted from International Wound Infection institute (2016); Swanson et al (2015a); Siddiqui and Bernstein (2010); World Union of Wound Healing Societies (2008); Enoch and Harding (2003); Sibbald et al (2003)
will only identify the level of bacterial load and sensitivities and/or resistance to antibiotics (Edwards-Jones and Flanagan, 2013).

Systemic antibiotics are recommended if infection of an acute wound is suspected in:
- Patients who are immunocompromised;
- Patients with diabetic foot ulceration;
- Patients with wounds where bone is exposed (Swanson et al, 2013; Edwards-Jones and Flanagan, 2013).

This is because the signs of infection may be absent and any delay in treatment could have catastrophic consequences, such as the need for amputation (Lipsky et al, 2012). In these patient groups, a course of systemic antibiotics combined with local antimicrobial wound care is considered the most appropriate management (Barrett, 2017; Jenull et al, 2017).

Fig 3 shows an infected acute wound – note the signs of spreading infection around the wound and the breakdown of the suture line.

Chronic wounds

Diagnosing wound infection in a chronic wound is less straightforward than in an acute wound – signs may be less obvious and routine swabbing is not recommended or helpful as there will probably be a ‘cock-tail’ of micro-organisms involved (IWII, 2016; WUWHS, 2008).

However, diagnosis is straightforward when there are obvious signs of spreading infection, or when systemic infection is suspected – for example, in cases of spreading cellulitis, life-threatening sepsis or necrotising fasciitis (IWII, 2016; Hewish, 2014). In these cases, treatment involves systemic antibiotics combined with good wound care (cleansing, debridement and use of topical antimicrobial products) (Swanson and Keast, 2017; Andriessen and Strohal, 2010).

Biofilms

A biofilm is “a dynamic community of bacteria and fungi living within a protective self-secreted matrix of sugars and proteins” (Wolcott and Rhoads, 2008). It is not possible to see a biofilm in a wound (Phillips et al, 2010) and, until recently, their existence in wounds was subject to debate (Bourdillon et al, 2017).

Some authors have suggested that a biofilm may be present in up to 60% of chronic wounds and may be responsible for delayed healing (James et al, 2008). However, others have suggested that wounds containing a biofilm can heal normally and do not develop infection (Percival et al, 2015). Further research on the identification of biofilms in wounds is needed; Box 1 lists the indicators suggesting the presence of a biofilm in a wound (Box 1).

Reducing bacterial burden in local infection

Wounds with local infection tend to have extensive slough in the wound bed, which increases the number of bacteria. The slough returns even after debridement and the granulation tissue may be of an abnormal dark red colour. Wound tissue that bleeds easily, malodour and stalled healing are also indicative of high bacterial burden (Hewish, 2014).

If a growing number of bacteria or the presence of biofilms is suspected in a wound with local infection, topical antimicrobial wound products should be the first-line treatment. This will prevent delayed healing and/or the infection becoming more serious (Hewish, 2014). If the presence of a biofilm is suspected, systemic antibiotics are not recommended as the biofilm may develop resistance. Systemic antibiotics are unlikely to be effective as they may not be able to penetrate and disrupt the biofilm (WUWHS, 2008).

Treatment should focus on disrupting the biofilm by continuous and regular debridement and the use of topical antimicrobial dressings (Wounds UK, 2013).

Antimicrobial wound products

Until fairly recently, a limited range of antimicrobial products was available to treat wound infections and reduce bacterial burden (Vermeulen et al, 2010). One of them was iodine – notably Inadine, which was introduced in the 1980s and contains 10% povidone iodine with an equivalent of 1% available iodine (Sibbald and Elliott, 2017). Today, there are several alternative antimicrobial wound products on the market, including silver, honey and pol-hexamethylene biguanide (PHMB).

The effectiveness of iodine in wound care has been debated, as there were concerns around toxicity and delayed granulation tissue development (Sibbald and Elliott, 2017). However, several studies – including a systematic review – have concluded that iodine-based products are effective antiseptic agents, have no associated adverse effects and are not inferior to any other antiseptic wound product (Sibbald and Elliott, 2017; Vermeulen et al, 2010).

Table 2 gives an overview of the four most common antimicrobial wound products, including their modes of action, advantages and disadvantages. All antimicrobial wound products should be used for two weeks initially and then reviewed.

Antiseptic solutions

Antiseptic solutions are skin disinfectants with broad-spectrum antibacterial, antiviral and antifungal activity. They are used for cleaning or irrigating infected wounds (IWII, 2016). Past concerns about toxic effects have resulted in limited use; however, these toxic effects were found in laboratory tests involving animal tissue and the evidence regarding their effects on human tissue is still evolving (WUWHS, 2008).

With this in mind, antiseptic solutions should not be used routinely, and clinicians should ensure their expected clinical benefit outweighs their potential negative impact on healing (WUWHS, 2008).
<table>
<thead>
<tr>
<th>Table 2. Overview of four common antimicrobial products</th>
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</thead>
<tbody>
<tr>
<td>Product</td>
</tr>
<tr>
<td>Iodine (PVD-I)</td>
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<tr>
<td>Iodine 0.9% in a paste</td>
</tr>
<tr>
<td>Iodoflex paste (cadexomer iodine)</td>
</tr>
<tr>
<td>Iodosorb powder or ointment (cadexomer iodine)</td>
</tr>
<tr>
<td>Silver</td>
</tr>
<tr>
<td>Acticoat, Acticoat 7, Acticoat Flex</td>
</tr>
<tr>
<td>Allevyn Ag range</td>
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<tr>
<td>Aquacel Ag range</td>
</tr>
</tbody>
</table>

* DNA = deoxyribonucleic acid; MRSA = meticillin-resistant Staphylococcus aureus; MRI = magnetic resonance imaging; PVD-I = povidone iodine. 
* Source: Adapted from Wounds UK (2013).
### Table 2. Overview of four common antimicrobial products (cont)

<table>
<thead>
<tr>
<th>Product</th>
<th>Mode of action</th>
<th>When to use</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Honey</strong></td>
<td>Removes bacteria as a result of its anti-inflammatory, antibacterial and anti-oxidant actions, which are due to acidity, slow hydrogen peroxide release and osmotic effects (Yaghoobi et al, 2013)</td>
<td>Use on all wounds with high level of bacteria and in cases of confirmed infection; not suitable for very wet wounds</td>
<td>Broad spectrum of activity</td>
<td>Can cause sting on application; exudate levels may increase initially</td>
<td>Do not use in patients who are allergic to bee venom; blood sugar levels should be monitored in patients with diabetes as a precaution (Majtan, 2011)</td>
</tr>
<tr>
<td><strong>L-Mesitran Soft ointment dressing</strong></td>
<td>Broad spectrum of activity Use on all wounds with high level of bacteria and in cases of confirmed infection; not suitable for very wet wounds</td>
<td>Products have debriding and odour-control properties; can be used in cavities</td>
<td>Can be used in combination with systemic antibiotics and on its own when a high bacterial burden is suspected, including in suspected MRSA infection</td>
<td>Can lead to pain on application; exudate levels may increase initially</td>
<td>Do not use in patients with local infection or high bacterial burden is suspected</td>
</tr>
<tr>
<td><strong>Medihoney antibacterial dressing range</strong></td>
<td>Use on all acute and chronic wounds, including wounds with high level of bacteria and in cases of confirmed infection; not suitable for very wet wounds</td>
<td>Use on most slightly to moderately exuding wounds, both deep and superficial</td>
<td>Broad spectrum of activity against Gram-positive and Gram-negative bacteria, fungi and biofilms (Andriessen and Strohal, 2010)</td>
<td>Has low toxicity and can be used for long periods; also available as a cleansing solution (Prontosan)</td>
<td>Do not use in patients with sensitivity to PHMB; consult product insert to check suitability according to exudate levels and wear time</td>
</tr>
<tr>
<td><strong>Suprasorb X+PHMB</strong></td>
<td>Use on all lightly to moderately exuding wounds, all acute and chronic wounds, wounds with high level of bacteria, and in cases of confirmed infection</td>
<td>Can be cut and folded to wound shape/size; available in rope</td>
<td>Broad spectrum of activity against Gram-negative bacteria and fungi (Andressen and Srolia, 2010)</td>
<td>Relatively high unit cost</td>
<td>Not suitable as principal treatment in confirmed systemic infection, but can be used in combination with systemic antibiotics</td>
</tr>
<tr>
<td><strong>Kendall AMD foam range</strong></td>
<td>Both adherent and non-adherent versions available</td>
<td>Suitable for moderately to heavily exuding wounds; various sizes and shapes available</td>
<td>Both adherent and non-adherent versions available</td>
<td>Both adherent and non-adherent versions available</td>
<td>Both adherent and non-adherent versions available</td>
</tr>
</tbody>
</table>

**Branded examples**

- L-Mesitran Soft ointment dressing
- Medihoney antibacterial dressing range
- Suprasorb X+PHMB
- Kendall AMD foam range

**Notes**

- MRSA = methicillin-resistant *Staphylococcus aureus*; PHMB = polyhexamethylene biguanide.
- Source: Adapted from Wounds UK (2013).
example of appropriate use would be on a deep sacral wound (Fig 4) in a patient with faecal incontinence to avoid infection.

Table 3 gives an overview of the most common topical antiseptic solutions.

**Conclusion**

Choosing the most appropriate antimicrobial product to manage wound infection can be challenging. Antimicrobial products are expensive and sometimes inappropriately used (O’Brien et al, 2016). Health professionals are advised to closely check wounds at each dressing change and review treatment every two weeks to determine its effectiveness. They are also advised to consult local wound care formularies for guidance on the criteria for use and discontinuation, to ensure their wound management practice is effective for patients and cost-effective for the NHS. NT

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**Table 3. Common antiseptic solutions**

<table>
<thead>
<tr>
<th>Type</th>
<th>Mode of action</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyhexamethylenebiguanide (PHMB)</td>
<td>Disrupts biofilm attachment when applied to wound surface</td>
<td>Available in gel or irrigation solution Apply for 10-15 minutes Gel can be used for cavities and deep wounds Do not combine with other solutions Use with caution in babies and in pregnant or lactating women</td>
</tr>
<tr>
<td>Povidone iodine (PVD-I)</td>
<td>Reduces mature biofilms and stops development of new biofilms</td>
<td>Not for long-term use (use for two weeks and review) May inhibit wound healing if used for prolonged periods of time Do not use in patients with renal or thyroid disease or extensive burns</td>
</tr>
<tr>
<td>Octenidine dihydrochloride</td>
<td>Prevents formation of new biofilms for at least three hours and bacterial growth for up to 72 hours</td>
<td>Available in gel or irrigation solution Apply directly to the wound and leave for at least five minutes Do not use in patients with known sensitivity to octenidine, on exposed joint surfaces or in abdominal cavities, eyes or ears</td>
</tr>
<tr>
<td>Hypochlorous acid (HOCL) and sodium hypochlorite (NaOCL)</td>
<td>Penetrates biofilm rapidly</td>
<td>Sometimes used to de-slough wounds Not usually recommended unless there are no suitable alternatives (WUWHS, 2008)</td>
</tr>
</tbody>
</table>

Source: Adapted from International Wound Infection Institute (2016); Swanson et al (2015a); Siddiqui and Bernstein (2010); World Union of Wound Healing Societies (2008); Enoch and Harding (2003); Sibbald et al (2003)

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**References**


