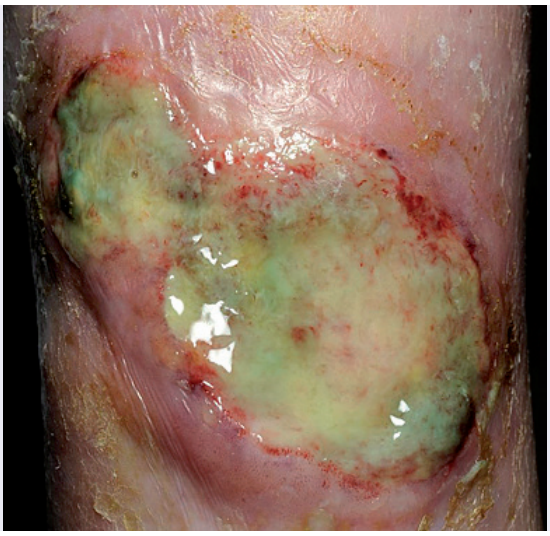
WUK BPS

Best Practice Statement

The use of topical antimicrobial agents in wound management

2013



THIRD EDITION

Assessing the patient and wound

Biofilms and wound infection

Selection and use of topical antimicrobials

Wound infection in different aetiologies

Wounds UK

BEST PRACTICE STATEMENT: THE USE OF TOPICAL ANTIMICROBIAL AGENTS IN WOUND MANAGEMENT (3RD EDITION) 2013)

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Developing Best Practice

There is a need for clear and concise guidance for UK clinicians as to how to deliver optimal care. One method of supporting clinicians is through the development of best practice statements (BPSs). In developing the *Wounds UK* Best Practice Statements, the relevant research has been reviewed, and expert opinion and clinical guidance have been sought. The key principles of best practice ensure increased clinician awareness, letting them exercise due care and process to promote delivery of the highest standards of care across all care settings, by all healthcare professionals.

BPSs are intended to guide practice and promote a consistent and cohesive approach to care. BPSs are primarily intended for use by registered nurses, midwives and the staff who support them, but can contribute to multidisciplinary working and guide other members of the healthcare team. Statements are derived from the best available evidence, including expert opinion at the time they are produced, recognising that levels and types of evidence vary. Information is gathered from a broad range of sources to identify existing or previous initiatives at local and national levels, to incorporate work of qualitative and quantitative natures, and to establish consensus. Written in accessible and meaningful language, best practice statements are targeted at clinicians.

The *Best Practice Statement: The use of topical antiseptics/antimicrobial agents in wound care* is now in its third edition. It seeks to integrate evidence-based wound management with expert opinion on practice. During the peer-review process, UK wound specialists have been invited to comment on the various drafts. Their expertise has been sought to cover best practice across relevant specialities and care settings, to support ongoing work to update regional, national and international guidance, and to provide practical advice to support clinical decision-making.

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The use of topical antimicrobial agents in wound management

Wound infection can be financially costly to healthcare organisations and can negatively affect quality of life for patients, families and carers, due to pain, malodour, frequent dressing changes, loss of appetite, malaise, or deterioration of glycaemic control in people with diabetes (WUWHS, 2008).

Cases of surgical site infection (SSI) can double length of hospital stay, and healthcare interventions for a patient with an SSI can cost £814 to £6,626, depending on the surgery type and severity of the infection (NICE, 2008). Pressure ulcers can cost an average of £1,214 (category 1) to £14,108 (category IV) each (Dealey et al, 2012). Venous leg ulcers cost the NHS nearly £200 million annually, and diabetic foot ulcers £300 million a year (Posnett and Franks, 2008). Furthermore, it's estimated up to half these wounds will become infected (Posnett and Franks, 2008), which can, in lower limbs, result in amputation — a life-changing outcome desired by neither clinicians nor patients.

Effectively managing and treating wound infection can challenge clinicians, with myriad products and pharmaceutical interventions available. The results of the Health Protection Agency's Point Prevalence Survey on healthcare-associated infections and antimicrobial use estimated the total number of antimicrobials prescribed as 25,942 for 18,219 patients, with the prevalence of antimicrobial drug and device use being 34.7% (HPA, 2011).

However, indiscriminate use of antimicrobials — in particular, antibiotics — has led to the rising prevalence of resistant organisms, with the potential to jeopardise patient outcomes (EWMA, 2013a).

Professor Dame Sallie Davies, Chief Medical Officer for England, recently highlighted the urgency of reviewing the use of antibiotics and antimicrobials. In her annual report, she stated: 'There is a need for politicians in the UK to prioritise antimicrobial resistance as a major area of concern, including it on the national risk register (specifically, the National Security Risk Assessment)' (Davies, 2013). Prof Davies warned that, during the next 50 years, microorganisms' drug resistance will increase, and new strains with resistance to a wide variety of agents will emerge, rendering antimicrobial drugs ineffective. She further suggested development of new antimicrobial agents has declined, leaving fewer options for treating infections (Davies, 2013).

It is therefore essential that clinicians be able to identify wound infections correctly and, when appropriate, choose the right topical antimicrobial and/or systemic antibiotics for treatment, with the goals of preventing/eradicating infection and promoting wound healing.

Effective management and treatment of wound infections is challenging. This document seeks to provide clinicians with a best practice guide on when — and when not — to use topical antimicrobial agents, comprising the following:

- Assessing the patient and wound (page 4)
- Biofilms and wound infection (page 8)
- Selecting and using topical antimicrobials (page 10)
- Considerations in different wound aetiologies (page 17)
- Decision-making algorithm for best practice (Appendix 1, page 21).

SECTION 1: ASSESSING THE PATIENT AND WOUND

Key points:

1. Before prescribing any wound products or medications, the clinician must undertake and document a holistic assessment of the patient.
2. Wound infection assessment should include examination of the wound bed and periwound area, documenting any signs of redness, unexplained pain or malodour.
3. Accurately assess the wound bed to help differentiate viable tissue from non-viable tissue.
4. Several classic signs and symptoms are easily identifiable as wound infection, but not all wounds will exhibit all these signs at any one time.
5. The value of a surface swab is debated.
6. If infection or colonisation is clinically diagnosed, use TIME to develop a wound management plan.
7. Wound healing is a complex and multifaceted process influenced by intrinsic and extrinsic factors, some of which can be controlled.

INTRODUCTION TO INFECTION

All wounds are contaminated with a variety of microorganisms (Stotts, 2004; WUWHS, 2008). In general, these microbes are harmless skin flora naturally found on the skin's surface. Intact skin provides a physical barrier against these microbes; however, the creation of a wound, acute or chronic, damages this defence mechanism, letting microbes enter the body.

Infections have been categorised into those that affect superficial tissues (skin and subcutaneous layer) of the incision and those that affect the deeper tissues (deep incisional or organ-space) (CDC, 2000). See Box 1 for further terms associated with microbes and their effect on the wound healing process that will be used throughout the document. Clinicians must be aware of the terminology and confident in their abilities to recognise each.

ASSESSING THE WOUND FOR INFECTION

Before prescribing any wound products or medications, the clinician must undertake and document a holistic assessment of the wound, including examination of the wound bed and periwound area, documenting any signs of redness, unexplained pain or malodour (Ousey and Cook, 2012). However, the assessment should not comprise the wound and its characteristics in isolation but, rather, account for a number of factors (see Box 2, page 3).

ASSESSING THE PATIENT'S INFECTION RISK

Wound healing is a complex and multifaceted process influenced by intrinsic and extrinsic factors, some of which can be controlled. Patient assessment should encompass the general medical condition, as immunocompromised, neonatal and elderly patients are at greater risk of wound infections (White, 2009). In addition, certain chronic medical conditions (eg diabetes), medications (eg oncology drugs) and lifestyle factors (eg smoking) put patients with wounds at greater risk.

Aetiological factors and comorbidities

Chronic medical conditions can continually erode the immune system, predisposing patients to complications simultaneously affecting several organs of the body, including the eye, blood vessels, kidneys and the nervous system (Ahmed, 2005). Immunosupression with increased bacterial virulence can make wound infection more likely (Wounds UK, 2010) and play a significant part in chronicity.

- **Diabetes.** Metabolic disorders associated with diabetes impair immune and inflammatory cells (Falanga, 2000), increasing the risk of wound infection and decreasing the potential for wound healing. Saad et al (2013) stated that neuropathy, peripheral vascular disease and minor trauma could contribute to impaired healing in diabetic foot ulcers, with Novak (2010) warning that

Box 1: Infection-related terminology

The WUWHS (2008) identified the presence of microbes in a wound can result in:

- **Contamination**, in which the microbial burden does not increase or cause clinical problems
- **Colonisation**, in which the microbes multiply, but wound tissues are not damaged; ie, the wound is on a normal healing trajectory with no clinical evidence of infection
- **Critical colonisation or localised infection**, in which microbes multiply and the wound moves from benign colonisation to an infected state with impaired healing but without tissue invasion or host immunological response (Moore et al, 2007). However, there is currently no consensus on how to define or identify critical colonisation (EWMA, 2013a)
- **Infection (spreading or systemic)**, in which the bacteria multiply, healing is disrupted and deep tissues are damaged. Bacteria might produce localised problems or cause systemic illness (sepsis).

intermittent claudication, absent pedal pulses and ischaemic gangrene were more prevalent in patients with diabetes. Diabetes in the presence of elevated blood glucose will further reduce neutrophil activity and interfere with the action of phagocytosis, thus delaying the normal inflammatory response. In addition, associated peripheral neuropathy will mask indicators of wound infection such as inflammation, pain and discomfort (Jones, 2012). Regular inspection of these wounds is paramount.

- **Circulatory disorders.** Oxygen is essential for cell metabolism and critical to all wound-healing processes. It prevents wound infection, induces angiogenesis, increases keratinocytes, enhances fibroblast proliferation and collagen synthesis, and promotes wound contraction (Bishop, 2008; Rodriguez et al, 2008). Systemic conditions such as ageing, diabetes and atherosclerosis can impair vascular flow, setting the stage for poor tissue oxygenation, increased infection risk and delayed healing (Guo and Dipietro, 2010). Poor tissue perfusion due to ischemia also might lower infection resistance. Clinicians should consider using topical antimicrobials in arterially compromised patients who have non-healing wounds, as reduced blood flow hinders cell, nutrient and oxygen transport to the wound bed (Lipsky and Hoey, 2009).

Lifestyle factors

- **Alcohol consumption.** Wigston et al (2013) identified that alcohol significantly affects non-healing. Excess alcohol consumption inhibits the inflammatory response, and delays collagen and epithelial cell production, and blood vessel growth during the proliferative stage of wound healing (Radek et al, 2009). Encourage patients to reduce alcohol consumption during wound healing.
- **Tobacco smoking.** Pharmacologically, smoking's influence on wound healing is multifaceted. The literature has identified smoking as a potential risk factor for wound infection due to delayed re-epithelialisation through nicotine-dependent downregulation of keratinocyte migration or from reduced monocyte and neutrophil oxidative burst activity, leading to a higher bacterial count in the wound bed (Kean, 2010). Smoking leads to tissue ischaemia due to its vasoconstrictive effect. It results in lower oxygen levels from preferential uptake of carbon monoxide, thereby limiting oxygen available for oxidative killing by white cells. Smoking impairs white blood cell migration, resulting in lower numbers of monocytes and macrophages in the wound bed, and reduces neutrophil activity, increasing the risk of wound infection and delayed healing (Ahn et al, 2008). Smoking reduces collagen production and deposition, and might also delay healing, mainly due to its immunosuppressive action (Sørensen et al, 2009). In addition, smokers exhibit delayed epithelisation, resulting in a dampened white cell and inflammatory response, which results in a higher bacterial count in the wound bed (Jones, 2012).
- **Nutrition.** Malnourished patients have a higher risk of infection and often experience chronic non-healing wounds with decreased tensile strength (Stechmiller, 2010).

Medications

Certain drugs that are vital to a patient's health status negatively affect the wound-healing process. In all cases, liaise with the prescriber to analyse risks and benefits before stopping prescriptions.

- **Antibiotics.** Although antibiotic therapy is sometimes necessary to treat wound infection, these drugs should be used only in clinically infected wounds (Karukonda et al, 2000b) to encourage wound healing. However, antibiotics might also reduce the wound's tensile strength, impeding final wound closure (Diehr et al, 2007).
- **Anticancer drugs.** Oncology drugs also negatively affect wound healing (Valls et al, 2009), but cessation is not advisable, so it is important that both the patient and the wound be carefully monitored and reassessed in a timely manner. Chemotherapeutic drugs inhibit cellular metabolism, cell division and angiogenesis and, therefore, inhibit many of wound repair's critical pathways (Guo

Box 2: Comprehensive wound assessment

A comprehensive wound assessment must consider and document the following aspects:

- Underlying cause
- Wound location and size
- Comorbidities
- Nutritional status of the patient
- Smoking habits
- Drug/alcohol use
- Mobility of the patient
- Circulation
- Infection
- Inflammation
- Odour
- Exudate
- Medication
- Site and type of pain, changes in nature or onset-triggers of pain
- Colour
- Periwound skin
- Wound bed
- Patient-centred concerns
- Patient's psychological status.

and Dipietro, 2010). In addition, they weaken the patient's immune functions, thereby impeding the inflammatory phase of wound healing and increasing the risk of wound infection.

- **Antiplatelet drugs.** Certain antiplatelet drugs have been found to hinder wound healing. Acetylsalicylic acid reduces platelet activation by preventing thrombus formation (Karukonda et al, 2000a). Patients should refrain from taking these drugs unless doing so is essential.
- **Glucocorticoid steroids.** These anti-inflammatory agents inhibit wound repair and suppress cellular wound responses. However, they are also essential in some autoimmune disorders that lead to wounds. Systemic steroids cause incomplete granulation tissue and reduced wound contraction, resulting in hard-to-heal wounds (Franz et al, 2007). Hydrocortisone and prednisolone stimulate the production of cortisol, which depresses the immune system, depleting either the neutrophils that move to the wound site or the concentration of the cytokines necessary for healing (Glaser et al, 1999).
- **NSAIDs.** Non-steroidal anti-inflammatory drugs (NSAIDs) are widely used to treat inflammation and pain. Short-term NSAID use does not adversely affect wound healing. However, long-term use might decrease fibroblast numbers, weaken skin strength, reduce wound contraction, delay epithelisation and impair angiogenesis (Dvivedi et al, 1997; Jones et al, 1999).

The clinician assessing the patient and wound must understand the repercussions of comorbidities, lifestyle factors and medications on the wound. This knowledge will help ensure an appropriate topical antimicrobial treatment plan that's been tailored to the patient is implemented.

DEVELOPING A WOUND MANAGEMENT PLAN

The International Advisory Board on Wound Bed Preparation developed a framework — known by the acronym TIME (see Box 3. TIME) — to provide a means by which clinicians can approach optimising the wound bed. If infection or colonisation is clinically diagnosed, use TIME to develop a wound management plan that includes removing non-viable tissue, reducing oedema and exudate, reducing the bacterial burden and correcting any abnormalities to promote wound healing (Schultz et al, 2003; Falanga, 2004).

Tissue management

Accurately assessing the wound bed will help differentiate between viable (eg granulation and epithelial) tissue and non-viable tissue (eg black eschar/necrosis and slough). Non-viable or devitalised tissue provides an opportunity for anaerobic and aerobic bacteria to grow, which can delay wound healing and result in significant malodour. (See Section 2: Biofilms and wound infection, page 6, for tissue-management strategies.)

Infection/inflammation

There is no hard scientific test to diagnose infection, so clinical judgement is needed to interpret signs and symptoms. The list of signs and symptoms is itself a topic of debate (see Table 1. Potential triggers for topical antimicrobial use, page 13), so the challenge is to make the best use of the clinical information available at the assessment, create a plan, and reassess regularly to determine treatment response and alter the care plan accordingly.

Several classic signs and symptoms are easily identifiable as wound infection, but not all wounds will exhibit all these signs at any one time. Localised infection is often characterised by the classical signs and symptoms of inflammation, pain, heat, swelling, redness and loss of function (WUWHS, 2008); these indicators are more likely to be apparent in acute wound infection than in chronic wound infection.

Additional, possibly more sensitive, criteria have been suggested for identifying wound infection, including abscess formation, cellulitis, discharge, delayed healing, discolouration, friable granulation tissue that bleeds easily, unexpected pain, pain that has changed in nature, tenderness, pocketing at the base of the wound, bridging of epithelium or soft tissue, abnormal smell and wound breakdown (Cutting et al, 2005). These kinds of

Box 3: TIME

T Tissue, non-vible or deficient
I Infection/inflammation
M Moisture imbalance
E Edge of wound non-advancing or undermined

so-called secondary wound infection characteristics might be better indicators in chronic wounds, particularly when classic signs are absent (Gardner et al, 2001).

There is little consensus to define whether wound microbiology is of use in guiding clinical decisions (Moore et al, 2007) because swabbing a wound will identify some or all bacteria within the wound, but might not always indicate the clinically significant species (Wounds UK, 2010). The value of a surface swab is debatable; tissue biopsy for quantitative microbiology is considered the most appropriate sampling method to identify wound infection and causative organism (Bowler et al, 2001; cited in Moore et al, 2007). This should be done after wound debridement — ideally, from the tissue or bone from the base of the wound, or a deep wound swab — and before systemic antibiotics are initiated (Saad et al, 2013).

Moisture imbalance

High levels of exudate are associated with bacterial colonisation of a wound (Cutting and White, 2002). When a wound becomes infected, exudate will increase rapidly, particularly in those with underlying co-morbidities such as diabetes. Discolouration and highly viscose exudate often indicate infection, especially when the exudate changes from pale amber colour to, for example, green (indicative of *P. aeruginosa*). However, a wound can be infected even if thick or discoloured exudate is absent (Wounds UK, 2013b). Further, diagnosis must also rule out conditions, eg lymphoedema or chronic venous insufficiency, that can cause excess exudate.

Clinicians must effectively manage exudate to create the optimal moist environment necessary for wound healing and to protect the surrounding skin from the risks of maceration and excoriation. Achieving these goals requires a detailed knowledge of dressing materials and their performance (Wounds UK, 2013b).

Edge of wound

Lack of improvement in wound dimensions and non-progression of the wound edge indicate failure to heal. The presence of devitalised tissue, such as areas of necrosis or slough, can delay wound healing. Healing rates are a reliable early predictor of complete wound closure; wound margin advance, initial healing rate, percent wound surface reduction and wound healing trajectories are powerful predictors of healing at 12 weeks (Cardinal et al, 2007).

BPS APPLICATION TO PRACTICE: ASSESSING THE PATIENT AND WOUND

Best practice statement	Reason for best practice statement	How to demonstrate best practice
Holistically assess each patient and rule out the need to treat underlying conditions before prescribing any wound products or medications	To prevent inappropriate products or medications being used	Clearly document the assessment process, including a plan of care, review dates for future assessments and the rationale for dressing choice Regularly review medications
Clinicians must ensure they understand the wound-healing process and are competent in accurate assessment	To ensure factors that might impede the complex wound-healing process are identified and, where possible, addressed	Clearly document the assessment process, including the wound bed condition, using an assessment tool (eg TIME) Refer the patient, in a timely manner, to the appropriate member of the multidisciplinary team if there is delayed wound healing or signs of infection

SECTION 2: BIOFILMS AND WOUND INFECTION

Biofilms are complex polymicrobial communities that develop on or near wound surfaces. Biofilms may not present with clinical signs of infection (Phillips et al, 2010), but their presence has been implicated in chronicity (Bjarnsholt et al, 2006; James et al, 2008). They are invisible to the naked eye, cannot be detected by routine cultures and are extremely difficult to eradicate (Phillips et al, 2010).

Not all biofilms are harmful, but some communities can be tantamount to wound infection, delaying healing as a result (Wolcott et al, 2008). The host's attempt to rid the wound of a biofilm stimulates a chronic inflammatory response, which releases high levels of reactive oxygen species (ROS) and proteases (MMPs and elastase). Although these substances help break down the attachments between the tissue and the biofilms, the ROS and proteases also damage normal and healing extracellular matrix tissues, potentially delaying healing (Wolcott et al, 2008).

DEVELOPMENT OF BIOFILMS

The extracellular polymeric substance that contributes to the structure of the biofilm lets microbial species exist in close proximity to one another. This matrix — which can be largely impermeable to antibiotics — acts as a thick, slimy protective barrier and attaches the biofilm firmly to a living or non-living surface.

Biofilms are dynamic and heterogeneous communities. They form quickly — within two to four hours — and evolve into a fully mature biofilm community within two to four days (Wolcott et al, 2008). They rapidly recover from mechanical disruption and reform mature biofilm within 24 hours. Communities can consist of a single bacterial or fungal species or, more commonly, can be polymicrobial (Dowd et al, 2008).

PREVALENCE OF BIOFILMS

Using electron microscopy and confocal scanning laser microscopy, biofilms have been found in 60% of biopsy specimens from chronic wounds, compared with only 6% of biopsies from acute wounds (James et al, 2008). Because biofilms are thought to significantly contribute to multiple inflammatory diseases, it is likely that almost all chronic wounds have biofilm communities on at least part of the wound bed (Phillips et al, 2010).

Although biofilms might be an important contributor to wound chronicity, not all wounds with delayed healing can be assumed to contain biofilm. Further, the distribution of biofilms when they do exist in wounds (49% of wounds in James et al [2008] were without biofilms) seems to depend on the species, with *P. aeruginosa* found in deeper wound areas than *S. aureus* (Fazli et al, 2009). In addition, it is not known whether the presence of a biofilm in a wound will always lead to problems.

WHEN TO SUSPECT A BIOFILM

Chronic skin wounds often lack overt clinical signs of infection and might have low bacterial burdens as measured by standard clinical microbiology laboratory assays (WUWHS, 2008). The term 'biofilm' was developed in an attempt to acknowledge that bacteria play a critical role in the failure to heal of wounds that do not have obvious signs of infection.

MANAGING BIOFILMS

Evidence to date suggests that debridement or vigorous physical cleansing, are the best methods for reducing biofilm burden (Wolcott et al, 2009). Before commencing debridement, however, the patient should be assessed to determine the wound's healing potential. Wound irrigation using sterile saline or tap water can be used to clean chronic wounds to allow assessment and debridement. It is important to remember to not use gauze or cotton wool during cleaning, to avoid leaving debris in the wound bed, which might in turn cause infection. Topical antiseptic agents are considered unnecessary for general wound cleansing, but might be of value when irrigating an infected cavity wound or chronic wounds at risk of infection (Bradbury and Fletcher, 2011).

Active debridement is contraindicated in cases of severe vascular compromise. When indicated, remove non-viable tissue as quickly and efficiently as possible using an appropriate debridement method to assist with assessment, reduce bioburden/biofilm

Key points:

1. Biofilms have been implicated in infections of many tissues; they are very likely to be implicated in chronic wounds.
2. Biofilms cannot be visualised or detected in the wound.
3. Treatment should anticipate biofilm's presence. The coordinated use of debridement and specific topical antimicrobials is advocated.

Box 4: Principles of biofilm management

When biofilm is suspected in a wound, treatment should aim to:

1. Disrupt the biofilm burden through regular repeated cleansing and/or debridement
2. Prevent the reformation and attachment of the biofilm.

and accelerate healing (Wounds UK, 2013). Clinicians can use autolytic, mechanical, sharp, larval therapy (biosurgical), ultrasonic, hydrosurgical and surgical debridement. Each clinician must be competent, skilled, educated and trained in each technique. The debridement method chosen should be determined by the patient's clinical need and choices, and not limited by the skills of the clinician (Gray et al, 2011).

Debridement with a monofilament fibre pad 'shows the potential to advance mechanical debridement as a viable technique, by providing a rapid, safe and easy-to-use method with limited pain for the patient' according to the EWMA (2013b). However, if this method is not available and the clinician has received no training in specific debridement skills, assistance and advice must be sought from a healthcare professional with expertise in debridement techniques.

There are relatively few wounds that are not safe to debride if the correct method is chosen. As a general rule, if the wound is not covered in granulation tissue, debridement can be performed to progress a wound towards healing (Wounds UK, 2013a).

Keep in mind that no form of debridement or cleansing is likely to remove all biofilm, so remaining bacteria/biofilm could reform into mature biofilm in a matter of days. Topical antimicrobial interventions are potentially more effective at this post-cleansing/post-debridement stage (Wolcott et al, 2009), and should be considered for application to the wound, either as an antiseptic wound-cleansing agent with a surfactant component and/or antimicrobial dressing.

Several antimicrobial agents have been shown to inhibit or even prevent biofilms *in vitro* (EWMA, 2013a). Sustained-release cadexomer iodine has been shown to be more effective than silver (Hill et al, 2010) or PHMB in disrupting mixed biofilms (Phillips et al, 2010); silver absorbent dressings have been shown to prevent biofilm formation by all singled and mixed biofilm cultures (Driffield et al, 2007). However, PHMB has also been shown to have microbiocidal activity on chronic wounds and burns, and to reduce biofilm in wounds exhibiting chronicity (Lenselink and Andriessen, 2011). Inert absorbent dressings have also been shown to exhibit both antifungal and antimicrobial effects, inhibiting *P. aeruginosa, K. pneumoniae* and *E. coli* presence in wounds, and significantly reducing *S. aureus* and *C. albicans* (Wiegand et al, 2012).

Use of topical antimicrobial agents in the presence of biofilms should occur only after biofilm disruption. These key steps summarise the management of biofilms in practice (Dowsett, 2013):

- Seek to prevent biofilm development whenever possible.
- Prepare the wound bed, considering the use of cleansing, debridement and topical antimicrobials where appropriate.
- Vigorously clean the wound with products designed to disrupt biofilm.
- Select debridement method based on wound type, best practice and patient preference.
- After debridement, consider topical antimicrobial treatment, as the biofilm is more vulnerable at this stage and can be managed with topical antimicrobial application more effectively than it could have been pre-debridement.

BPS APPLICATION TO PRACTICE: BIOFILMS AND WOUND INFECTION

Best practice statement	Reason for best practice statement	How to demonstrate best practice
Prevent biofilm development wherever possible	Biofilms can delay healing	Clearly track and document wound progress towards healing
Treatment should aim to disrupt biofilm burden through regular, repeated debridement and/or cleansing	To reduce the presence of biofilm and help prevent the reformation and attachment of biofilm	Patient documentation should reflect clinical rationale for treatment choice
Select debridement or cleansing method based on wound type, the clinician's knowledge and patient preference	To encourage effectiveness of treatment and patient concordance with the treatment chosen	Patient documentation should reflect clinical rationale for treatment choice as well as record of discussion with the patient
Consider topical antimicrobial treatment after cleansing or debridement	To better manage biofilm burden, as it is more vulnerable at this stage	Clearly document the rationale for pursuing treatment with a topical antimicrobial

SECTION 3: SELECTION AND USE OF TOPICAL ANTIMICROBIALS

Key points:

1. Topical antimicrobials present limited potential for systemic absorption and toxicity.
2. Topical antimicrobials are ideal for providing high and sustained concentration of antimicrobial at the site of the infection, potentially limiting the amount of overall antimicrobial needed in combination with systemic treatment.
3. Topical antimicrobials should be used only when signs and symptoms suggest that wound bioburden is interfering with healing, or when there is an increased risk of serious outcomes.
4. Not all wounds exhibit all symptoms of critical colonisation or infection, and there is not necessarily a standard progression of indicator severity.
5. Clinical colonisation must be determined in the context of all information about the wound and patient.
6. Topical antimicrobials vary according to the concentration and availability of the active ingredients, mode and duration of action, and ability to handle exudate, odour or pain, and should be selected specific to the needs of each wound and patient, weighing the advantages and drawbacks of use.
7. To avoid serious consequences of infection, clinicians must also identify high-risk patients for whom systemic antibiotics might be indicated.
8. Using topical antimicrobials does not guarantee a healing outcome, but is currently a reasonable, practical method for reducing the risks posed by infection at specific times on the wound care pathway.

In clinical practice, attributing either positive (clinical improvement) or negative (treatment failure) outcomes to topical antimicrobial treatment is currently not possible; it is a matter of reasoned opinion based on good clinical assessment. The important elements or treatment goals of using topical antimicrobials in a management plan are the potential to:

- Prevent progression from localised colonisation to more invasive infection states, thereby reducing the antibiotic usage
- Return to normal healing progression
- Treat critical colonisation/local infection without resorting to antibiotics
- Achieve faster resolution of local infection in conjunction with antibiotics (the literature does not prove this outcome advantage, but it is logical to expect more rapid resolution when reducing the wound-base pathogen reservoir and minimising antibiotic-resistant strains in the wound bed)
- Improve the patient experience by correctly diagnosing the cause of and controlling odour, exudate leakage and pain.

Clinically determining the patient's ability to resist bacterial invasion is the most important contributing factor in determining microbial balance (White, 2013). As such, topical antimicrobials should not be used 'just in case' in a wound that is healing as expected, unless clinically justified due to a patient's high risk (Butcher and White, 2013). For critically colonised or locally infected wounds, topical antimicrobials can be used, as part of a treatment plan as determined using the TIME framework, to help control microbial load (eg, biofilm) and protect the wound from further damage or contamination.

WHAT ARE ANTIMICROBIALS?

Antimicrobials are agents capable of killing (biocidal) or inhibiting (biostatic) microorganisms. They have broad-spectrum activity against potentially infection-causing Gram-positive, Gram-negative, aerobic and anaerobic, planktonic and sessile (Wolcott et al, 2008) bacteria, and fungi and spores commonly found in the wound bioburden. As many antimicrobials can adversely affect human tissue, a compromise between antibacterial efficacy and cytotoxicity might have to be accepted (Müller and Kramer, 2008). The umbrella term includes:

- **Disinfectants**, substances used to inhibit or kill microbes on inanimate objects (eg dressing trolleys and instruments)
- **Antiseptics**, agents used to inhibit or kill microorganisms within a wound (biofilm) or on intact skin (eg, iodine)
- **Antibiotics**, naturally occurring (produced by microorganisms) or synthetically produced substances that can act selectively and can be applied topically (not normally recommended in wound care) or systemically. Microbial resistance is common (Vowden et al, 2011).

According to Lipsky and Hoey (2009), topical antimicrobials are ideal for providing high and sustained concentration of antimicrobial at the site of infection, potentially limiting the amount of overall antimicrobial needed in combination with systemic treatment — perhaps eliminating systemic therapy altogether. Further, topical antimicrobials present limited potential for systemic absorption and toxicity (Lipsky and Hoey, 2009). Other benefits include:

- Relatively easy use
- Wide availability
- Generally lower cost than antibiotics
- Less risk for developing resistance (Vowden et al, 2011).

However, because of their surface nature, antimicrobials cannot be used to treat deep-tissue infection and might cause local hypersensitivity or contact dermatitis reactions at the skin and wound bed or alter normal skin flora, interfering with wound healing (Lipsky and Hoey, 2009).

Wound bioburden can also be managed via passive mechanisms without necessarily inhibiting the wound's microbial flora. Modes of action include bacterial sequestration (eg via mechanically modified cellulose fibres and selected gelling agents) within the dressing or binding of wound pathogens to a dressing substrate (eg via dialkylcarbamoylchloride, known as DACC). Bacteria and fungi that are bound in the latter manner are rendered inert on the wound contact layer, so no further replication takes place, and are removed from the wound environment when the dressing is changed.

WHEN ARE TOPICAL ANTIMICROBIALS INDICATED?

There are two broad categories of wounds in which topical antimicrobials should be considered for use. In the first kind of situation, no obvious underlying patient historical or lifestyle factors would compromise wound healing. In the second, underlying comorbidities and patient historical and lifestyle factors are present that might inhibit wound healing.

Situation 1

Topical antimicrobials should be used only when signs and symptoms suggest that wound bioburden is interfering with healing:

- Cessation of progress, where previously response to that same therapy was evident and when other potential reasons have been explored and eliminated
- Failure to heal despite proper treatment — meaning wound care has included adequate debridement, removal of foreign bodies, pressure offloading (not leg ulcers), appropriate dressings, and treatment of any arterial or venous insufficiency or metabolic derangements (Lipsky and Hoey, 2009)
- Signs and symptoms of critical colonisation or localised infection (covert infection)
- Signs and symptoms of overt local or spreading infection.

Situation 2

In some circumstances, there is an increased risk of serious outcomes; as such, the use of topical antimicrobials should be considered when there is:

- A history of delayed healing
- Gross contamination (eg combat injuries) that presents risk of cross-infection with multidrug-resistant bacteria to vulnerable patients in close proximity
- Presence of beta-haemolytic streptococci
- A delay in initiation of effective therapy of four or more weeks, with no visible signs of healing or with signs of continuing deterioration
- A traumatic origin involving contaminated materials, including pet scratches and soil (eg gardening and sports field injuries)
- Evidence of pathologies or activities likely to compromise immunity (eg in diabetes with poorly controlled blood glucose, smoking, regular alcohol use beyond recommended limits, and substance abusers, particularly when ulceration results from the method of drug administration)
- Significantly compromised flow (eg arterial ulcers) where healing is unlikely without vascular intervention
- Odour that affects quality of life.

CONSIDERATIONS WHEN SELECTING TOPICAL ANTIMICROBIALS

Products vary according to the concentration and availability of the active ingredients, mode and duration of action, and ability to handle exudate, odour or pain, and should be selected specific to the needs of each wound, weighing the advantages and drawbacks of use (see Box 5).

Box 5: Keys to selecting topical antimicrobials

Key considerations include:

- Why is an antimicrobial dressing required?
- Has the wound been debrided?
- Is exudate controlled?
- Is there odour?
- Is the antimicrobial agent chosen likely to be effective against the known or suspected microorganisms?
- Is there any laboratory or clinical evidence to support dressing use?
- Are there any contraindications such as known allergies to dressing components?
- Is pain a consideration?
- What does the patient prefer?
- What is the product's availability?
- Is it cost-effective?

To avoid serious consequences of infection, clinicians must also identify high-risk patients, such as those with poor vascularity or compromised immune systems, for whom the systemic antibiotic use might be indicated. For spreading infection, systemic antibiotics are normally selected empirically (EWMA, 2013a).

TWO-WEEK REVIEW

Once started, the effect of the antimicrobial on the wound must be closely monitored. The wound should be reviewed at each dressing change and fully at two weeks. Take the following actions in the follwing situations:

- If there are signs of progression and a reduction in the signs and symptoms of infection or critical colonisation, discontinue the antimicrobial dressing.
- If the wound shows signs of progression and of infection, continue with the antimicrobial dressing for a further two weeks, unless the wound deteriorates earlier.
- If the wound deteriorates, fully reassess to exclude contributing causes (other than infection) that might indicate an alternative approach or the addition of systemic therapy (Wounds International, 2013a).

A multidisciplinary approach, together with a treatment pathway that enables timely referral to specialists, is important for optimal outcomes, followed by accurate and ongoing assessment to evaluate (1) the progression of the wound and (2) the effect of the current treatment objectives. The results should be clearly documented in the patient's notes and treatment plan, with any changes to treatment and a clear rationale for such changes recorded (Ousey and Atkin, 2013).

EVIDENCE FOR USE

Definitive evidence of topical antimicrobial effectiveness from randomised controlled trials (RCTs) is lacking. A recent analysis of 149 Cochrane systematic reviews found few interventions for local and systemic infections provided strong conclusions regarding effectiveness (Brölmann et al, 2012). However, the significant body of expertise based on benefits of using antimicrobial therapy in clinical practice is difficult to discount (EWMA, 2013a). A Cochrane review concluded 'there is some evidence to support the use of cadexomer iodine' in venous leg ulcers (O'Meara et al, 2010).

Two influential Cochrane reviews and a high-profile RCT that concluded there is insufficient evidence to recommend silver dressings (Vermeulen et al, 2007; Storm-Versloot et al, 2010; Michaels et al, 2009) have caused controversy. However, the dressings in these were often used for extended periods and on wounds that were not infected or showed no evidence of heavy bioburden.

Although the recent data have cast doubt on the on silver dressings for managing wound infection (Wounds International, 2013a), their efficacy has not been dismissed entirely. A 2010 meta-analysis found 'evidence that silver-impregnated dressings improve the short-term healing of wounds and ulcers' (Carter et al), and a new meta-analysis found statistically significant evidence in favour of using silver dressings to treat hard-to-heal venous leg ulcers (Leaper, 2013), which could extend to other wound types.

Difficulties in interpreting and comparing studies arise from the small number of patients in some studies, which may cause issues with insufficient study power and problems with randomisation. As highlighted previously, many of the studies have included endpoints related to healing. However, more accurate endpoints for antimicrobial dressings might relate to measurement of wound bioburden and assessment of the clinical indicators of infection (Wounds UK, 2011).

Further questions that need to be explored:

- Which microbes are responsible for chronicity, and are these susceptible to topical antimicrobials in common use?
- Are resistant strains preventing wound-healing progression?
- Are all wound microbial species equally susceptible to each of the available topical agents?
- Do some strain-variants of target organisms survive to continue wound infection at low level, reducing the impact of effectiveness of topical agents?
- Does bacteria regrowth occur because some agents lose effectiveness during their application periods on the wound?
- Does topical antimicrobial application cause an unintended survival stress in the microbes that causes phenotype change, such as a boost to biofilm production that delays full recovery of healing momentum?
- Do all topicals in all formulations effectively penetrate all tissue types in a wound, or are pockets of protected bacteria sufficient to

maintain an inflammatory response that delays wound healing?

Using antimicrobials provides no assurance of a healing outcome. However, topical antimicrobial use is currently a reasonable, practical — though imperfect — method to reduce the risks posed by infection at specific times on the wound care pathway. It is important to not use these products when infection is not present, or where there is no clinical risk of infection (BPS, 2011).

Table 1: Potential triggers for topical antimicrobial use

Not all wounds exhibit all symptoms, and there isn't necessarily a standard progression of indicator severity; this table merely attempts to help delineate them. The clinician must decide in the context of all information about the wound and patient. Further, topical antimicrobial treatment should not be considered a standalone solution, but rather part of the total wound treatment regimen.

Potential signals	Contamination/ critical colonisation/localised infection	Spreading infection	Systemic infection
Granulation	Abnormal/absent granulation	Abnormal/absent granulation, or necrosis within wound margins or in previously undamaged skin surrounding original wound	Abnormal granulation or necrosis
Wound margin	Redness	Suspected pocketing or tunnelling	Pocketing, tunnelling, maceration
	Oedema	Redness	Redness
	Warmth at the site	Oedema	Oedema
		Warmth at the site	Warmth at the site
Size	Static	Static or enlarged	Enlarged
Exudate	Minimal	Excessive or increased serous fluid	Excessive and purulent
Odour	Some odour	Some odour	Foul or excessive odour
Erythema	>0.5cm to ≤2cm around the ulcer	>2cm around the ulcer	>2cm around the ulcer
Depth	Only skin and subcutaneous tissue affected	Only skin and subcutaneous tissue affected	Involving structures deeper than skin and subcutaneous tissues (eg, abscess, osteomyelitis, septic arthritis, necrotising fasciitis)
Pain	New-onset pain	New-onset pain	New-onset pain
	Pain that has changed in frequency, severity, time of day, or activity triggers	Pain that has changed in frequency, severity, time of day, or activity triggers	Pain that has changed in frequency, severity, time of day, or activity triggers
	Pain that has changed in character/patient description	Pain that has changed in character/patient description	Pain that has changed in character/patient description
Systemic inflammatory response signs			Body temperature >37°C
			Heart rate >90 beats per minute
			Respiratory rate 20 breaths/ minute or PaCO2 <32mmHg
			White blood cell count >12,000 or <4,000 cells/μL or ≥10% immature (band) forms
If you suspect ...	**Contamination/ colonisation/localised infection**	**Spreading infection**	**Systemic infection**
	Use a topical antimicrobial if infection risk is a concern (eg the patient presents with comorbidities that increase infection likelihood, the patient has a history of wound infection) and there are signs of critical colonisation/localised infection	Use a topical antimicrobial; consider systemic antimicrobial therapy	Intervene with systemic antibiotics. Consider a topical antimicrobial if localised effect is desired, and the wound status allows dressing application and change without further damage to surrounding structures

Refer to Section 4: Wound infection in specific aetiologies, page 17, for further advice.

BPS APPLICATION TO PRACTICE: SELECTING AND USING TOPICAL ANTIMICROBIALS

Best practice statement	Reason for best practice statement	How to demonstrate best practice
Consider topical antimicrobial treatment for patients who present with signs and symptoms of critical colonisation, local infection or a history of wound infection with a high risk of reinfection	Topical antiseptics/antimicrobials can help reduce wound bioburden	Document use of antiseptic/antimicrobial and provide rationale for use
Consider systemic antibiotic therapy either alone or in combination with topical antimicrobials for patients who present with spreading infection or at risk of spreading infection	Patients with recurring infection are at risk of cellulitis and spreading infection that can develop within a short time	Document use of systemic antibiotics, alone or in combination with and antimicrobials, and provide rationale for use
Do not use topical antiseptics/antimicrobials for patients being treated with standard care and who have no signs of infection	Using antimicrobials inappropriately increases the risk of selecting for bacterial resistance	Document that the patient does not exhibit signs of infection as rationale for following standard wound care
Clearly state the rationale for starting treatment, prescribed duration and treatment goals in the patient's health records	Treatment goals allow for objective evaluation of wound outcome	The patient's health record must accurately reflect clinical need, ie, wound deterioration or failure to progress to healing
Follow manufacturers' guidelines, using products in line with licence	Failure to follow manufacturers' guidance might lead to inappropriate care	The patient's health record must demonstrate the products are being used in line with manufacturer's guidance, or contain rationale for not following instructions
Select products to reflect clinical and patient needs	Each patient will have different clinical indications and psychosocial requirements	Document a clear rationale supporting the product selected in the patient's health records
Do not use more than one topical antimicrobial product in combination	Multiple topical antimicrobials used on the same wound are likely to contradict manufacturers' guidance and might compromise the patient	Document which product has been selected along with rationale for following (or not following) manufacturer instructions
For the majority of patients, the initial prescription should be for 14 days with a formal review of treatment objectives at around 7 days. However, review should be conducted at each dressing change by a qualified healthcare professional	Wounds can improve or deteriorate over time and, therefore, timely recognition of any changes is essential	The patient's health records must demonstrate a clear, auditable trail of product selection, application and review in line with manufacturers' guidelines. Include a clear plan of care determining expected outcomes with evidence of planned systematic review
The patient's health records should contain clear evidence that, at each dressing change, the patient has been assessed in line with the stated treatment objectives	Failure to demonstrate evidence of ongoing review can contribute to delayed healing and development of spreading infection	Document the dates and number of dressing changes, and the results of each patient and wound assessment
By 14 days, if there is deterioration in the wound with signs of spreading infection, discontinue current treatment and consider systemic antibiotics and/or alternative topical treatment	If a wound fails to respond to treatment there might be another clinical differential diagnosis, such as vasculitis or carcinoma, many of which require specialist input	Record any changes to treatment and a clear rationale for such changes in the patient's health records. Document evidence of specialist referral and record of specialist consultation
Do not extend a prescription beyond 14 days without discussion with local specialist, unless previously agreed or indicated by clinical need	Use of antimicrobials after 14 days might be justified if the wound shows signs of improvement in line with treatment goals, but signs of infection remain	Document rationale for continued use, supported by multidisciplinary clinical assessment and specialist support
If the treatment has not been successful without obvious reason, discontinue it and start a new assessment and prescription	If treatment is not successful, comprehensively review the wound/patient and devise a new treatment plan to show rationale for change	Document evidence of a clear, concise plan of action and rationale for changing the dressing selection and ongoing treatment plan

Table 2. Guide to topical antimicrobials

This table presents the key points of widely used types of topical antimicrobials, listed alphabetically. Always check manufacturer instructions for use and contraindications. Select the antimicrobial product on an individual basis, customising the agent and dressing choice according to patient, wound and environment needs.

Active control	Mode of delivery	Rationale for use	Wound types	Guidance for use	Contraindications
Enzyme alginogel	Alginate gel	• Autolytic debridement • Maintain moisture balance • Reduce microbial burden • Protect wound edges and epithelial cells	• Pressure ulcers • Diabetic ulcers • Traumatic wounds • Arterial ulcer • Second-degree burns • Radiotherapy and oncology wounds • Treat pregnant patients, as there is no absorption into the body	• Apply to wound and cover with a secondary dressing • Check frequently to ensure correct level of gel • Can be used long-term due to no body absorption	• Patients with known sensitivity alginate dressing or polyethylene glycol • Wounds on the eyelid or where there is danger of contact with the eye
Iodine - Povidone iodine - Cadexomer iodine	Solution, cream, ointment, spray or impregnated dressings	• Treat localised infection, or spreading infection when healing is delayed • Prevent wound infection or recurrence in susceptible patients • Rapidly kill microorganisms, including MRSA • Prevent bacterial resistance • Suppress biofilm formation	• Venous leg ulcers • Diabetic ulcers • Cavity wounds (cadexomer only)	• Use initially for one week only, with dressing changes 2 to 3 times weekly • If the wound does not improve after 10 to 14 days, re-evaluate the wound and change the dressing regimen/systemic treatment	• Long-term use (due to perceived issues with toxicity, systemic absorption and delayed healing) • Known or suspected iodine sensitivity • Children • Before after radio-iodine diagnostic tests • Patients with significant renal disease • Patients with thyroid disease
Medical-grade honey	Gel or ointment, impregnated dressings, gel sheet or barrier cream	• Autolytic debridement to reduce slough and necrosis • Manage wound bioburden • Reduce odour • Decrease wound-related pain • Impede biofilm formation/disrupt established biofilm	• Venous and arterial eg ulcers • Superficial and partial-thickness burns • Diabetic foot ulcers • Pressure ulcers • Traumatic and surgical wounds • Graft sites • Paediatric wounds	• The frequency of dressing changes/gel application will depend on how quickly the honey is diluted by exudate • Ensure direct contact with the wound bed. Fill any cavities with gel or ribbon dressing • Use secondary dressing to contain seepage of diluted honey for moderate to highly exuding wounds	• With monitoring of blood sugar levels in patients with diabetes when using honey • With caution in patients with bee venom allergy • Full-thickness burns • Letting the dressing dry out
Octenidine	Solution and gel	• Cleanse/decontaminate the wound • Manage wound bioburden/biofilm • Removal of necrotic tissue • Donate moisture to the wound	• Burns • Pressure ulcers • Leg ulcers • Diabetic foot ulcers • Paediatric wounds	• Apply directly to the wound bed • Leave solution for at least 5 minutes • Solution can be used to soften dressings before removal and to loosen encrusted coatings	• In patients with known sensitivity to octenidine • On exposed joint surfaces/cartilage • In abdominal cavities • In eyes or middle and inner ears

Polyhexamethylene biguanide (PHMB)	Solution, gel or impregnated dressings	• Cleanse/ decontaminate the wound • Suppress biofilm formation • Reduce wound odour • Removal of encrusted dressings (solution only) • Manage wound bioburden • Provide an antimicrobial barrier	• Partial-thickness burns • Post-surgical wounds • Traumatic wounds • Skin donor/recipient sites • Leg ulcers • Pressure ulcers • Diabetic foot ulcers • Scleroderma wounds • Paediatric wounds	• Apply solution to wound and leave for 10 to 15 minutes (can be warmed to body temperature) • Gel can be applied to deep or tunnelling wounds and cavity wounds. Leave in place and apply secondary dressing • Dressings can be left in place for up to 5 to 7 days	• Patients with known PHMB sensitivity • Combined with other wound cleansers (eg Dakin's) or ointments • With caution/under medical supervision in pregnant and lactating women or babies • With peritoneal or joint lavage
Silver - Metallic - Nanocrystalline - Ionic	Impregnated dressings and paste	• Manage wound bioburden • Provide an antimicrobial barrier	• Traumatic wounds • Surgical wounds • Chronic wounds • Some paediatric wounds	• Apply directly to wound. • Some dressings require wetting before application to activate silver.Use for 2 weeks. If there are signs of improvement, continue use up to 4 weeks. If there are no signs of improvement, discontinue use • Do not use longer than 4 weeks without good clinical rationale	• Long-term use (due to risk of argyria) • Large surface areas • Acute/chronic wounds healing as expected • Patients with known sensitivity to silver • Pregnant or lactating mothers and babies • During MRI or on/near body sites undergoing radiotherapy
Silver sulfadiazine	Cream and impregnated dressings	• Prophylaxis and treatment of infection in burns, leg ulcers and pressure ulcers	• Second- and third-degree burns • Leg ulcers • Pressure ulcers	• Use for 1 week only. If there is no improvement, continue to use up to 2 weeks. If there are no signs of improvement, discontinue use. Do not use longer than 2 weeks • Instruct the patient to clean the wound and cover with 0.3cm to 0.5cm thickness of cream, keeping covered with cream at all times	• Use longer than 2 weeks • Babies younger than 2 months • Allergy to silver sulfadiazine and sulpha drugs * Use with supervision in patients with liver or kidney disease and pregnant or breast-feeding women
Passive control	**Mode of delivery**	**Rationale for use**	**Wound types**	**Guidance for use**	**Contraindications**
Dialkylcarbamoylchloride (DACC)	DACC-coated dressings (wound contact layer, ribbon, round swabs, absorbent pads, foams, hydropolymer gel matrix)	• Irreversibly bind and inactivate bacteria and fungi, reducing microbial load in moist wounds without donating chemicals to the wound bed • Absorb exudate and debride sloughy wounds • Prophylactically treat high-risk patients/ wounds	• Pressure ulcers • Leg ulcers • Diabetic foot wounds • Traumatic and post-operatively dehisced surgical wounds • Sinus and cavity wounds • Wounds in paediatric and pregnant patients • Burns • Over-granulated wounds	• Use as the primary dressing • Perform dressing changes as needed	• In combination with other ointments and creams, as binding effect might be impaired
Absorbent cellulose fibres gelling agents	Dressings	• Autolytic debridement to remove slough • Absorb exudate, removing bacteria and fungi from the wound bed • Reduce protease levels	• Moderate to heavily exuding wounds	• Apply to the wound bed and change dressing according to exudate levels	• Avoid on wounds with little or no fluid

SECTION 4: WOUND INFECTION IN SPECIFIC AETIOLOGIES

LEG ULCERS

The best way to prevent infection in leg ulcers is to close the ulcers as soon as possible and, for venous ulcers, this means compression. Leg ulcers have no special factors to look for over other open wounds, but will often require periods of antimicrobial product use because a large proportion of such wounds are:

- older than 4 weeks
- large (sometimes circumferential)
- heavily exuding
- painful
- difficult to treat immediately with effective ulcer closure therapy because preparatory work to debride scale, control pain, decrease debilitating odour, manage varicose eczema or deal with skin sensitivities known to be more highly prevalent in this group of patients (Saap et al 2004).

To assess for and address underlying causes (eg superficial or deep vein incompetence), refer patients to vascular services if the wound is not healed at two weeks (NICE, 2013).

Any significant delay before properly assessing and diagnosing lower leg wounds can let chronicity factors, including topical bioburden, develop. Wounds of traumatic origin on the lower leg are likely to ulcerate if there is underlying venous and/or arterial pathology, meaning they will gradually enlarge and remain open unless effectively diagnosed and managed.

Leg ulcers very rapidly become colonised by multiple species of microorganisms, which are typically present in heterogeneous distribution on and in the surface tissues. There is also a high likelihood that pathogenic species such as *S. aureus*, and those known to cause healing disruption, such as *P. aeruginosa*, will reside in the wound (Kucharzewski et al, 2008).

Unless the ulcer is failing to heal with appropriate therapy or if the ulcer is displaying overt signs of infection, then antimicrobial intervention is not warranted. However, topical antimicrobial therapy might help maintain the ulcer colonisation at a level the patient's immune system can manage in certain situations:

- **If the ulcer is colonised with beta-haemolytic streptococci.** This pathogen is a more aggressive organism than normal wound colonisers, causing significant local damage if infection occurs and potentially having greater systemic consequences. As such, its presence warrants potentially using 'kill-on-sight' approaches. Streptococci's presence will be unknown unless wound screening has been undertaken.
- **If the patient has a history of failed healing or delayed healing, and the delay was attributed to the effects of microorganisms.** This is most likely to occur in recurrent ulceration where previous ulcers have had delayed healing, but can be identified from previous wounds that did not heal.
- **Vulnerable structures such as bone or tendon are visible in the wound.** If these structures became infected, the patient would experience more serious outcomes than the normal localised infection of soft tissues.
- **The patient has underlying pathology that compromises the immune system to such an extent that the risk of overt infection and the seriousness of the outcome are both increased.** However, determining this is presently a clinical art rather than investigatory science. For example, the mere presence of diabetes cannot be presumed to cause immune suppression that would prevent a normal level of immune control in the ulcer. The clinician must therefore have a high index of suspicion for healing problems and be able to respond rapidly to any early signs or symptoms which, for practical care purposes, might be translated into a higher frequency of redressing to enable more wound bed assessment and more rapid review if the patient reports any negative change.

These exceptions can lead antimicrobial dressing use outside the norm. However, the rationale for this should be documented

Key points:

1. Treatment of wound infection should account for any special considerations presented by the differences that manifest due to variations inherent in each wound aetiology.

and a care plan made to reflect the need for increased observation and progress quantification.

DIABETIC FOOT ULCERS

Diabetic foot ulcers (DFUs) are usually the result of minor trauma that might have occurred as a result of decreased sensation due to neuropathy or poor tissue viability, which is caused by reduced vascular supply. Many patients have a combination of neuropathy and poor vascular supply. Ulceration in areas of increased pressure is also common. Offloading, debridement, effective wound care and close follow-up are recommended for these wounds (Wounds International, 2013b).

Many patients with DFUs will develop infection (Lavery et al, 2006), which can spread rapidly and, when not managed effectively, can deepen wounds, leading to osteomyelitis and serious soft tissue infection (O'Meara et al, 2006). Promptly identifying and managing infection is crucial to preventing limb loss. In addition, infection in the feet can spread elsewhere through the blood, leading to potentially life-threatening complications (Kerr, 2012).

However, recognising infection in the diabetic foot is often difficult; up to 50% of patients with infected DFUs will not present with the classical signs of redness, heat, swelling and pain due to neuropathy (Edmonds and Foster, 2006). This can be due to a poor blood supply that reduces the classical signs of infection, an immunocompromised host and pain-masking neuropathy. In the absence of pain, or altered sensation, other, often more subtle, signs of infection might be visible and should not be ignored (Edmonds et al, 2004). Infection might occur in any foot wound in a patient with diabetes; it is important to be aware of factors that increase infection risk (Lipsky et al, 2012).

Infective states in DFUs have been classified as no infection, mild infection, moderate infection and severe infection (Lipsky et al, 2012). Mild to moderate infection can be managed on an outpatient basis with broad-spectrum antibiotics for one to two weeks (Lipsky et al, 2012). Deeper wounds with exposed or palpable bone or radiological changes, and wounds with residual signs and symptoms of infection often require antibiotic therapy for longer than six weeks. Individuals with severe infection require hospital admission for intravenous antibiotic therapy (Edmonds, 2005). Wounds without evidence of soft tissue or bone infection do not require antibiotic therapy (Lipsky et al 2012).

Topical antimicrobial cleansing agents and dressings have an increasing role in managing diabetic foot infections due to problems such as antimicrobial resistance (eg meticillin-resistant *S. aureus* [MRSA]) or other adverse effects of systemic therapy (*C. difficile*). They do not replace antibiotic use when there are frank signs of infection, but can be used as an adjunctive therapy to provide antimicrobial treatment directly at the wound/dressing interface. This can be important where there are concerns regarding reduced antibiotic tissue penetration — for example, if the patient has a poor vascular supply. In addition, topical antimicrobials are often used in cases in which the classical signs and symptoms of infection might be absent, but where there is a clinical suspicion of increased bioburden. This can present as increasing exudate, darkened granulation tissue, odour and a non-healing wound (Edmonds et al, 2004).

Institute CPR — check, protect, refer — for patients with DFUs, to ensure they receive referral to a foot-protection team.

PRESSURE ULCERS

Pressure ulcers (PUs) provide a portal of entry for bacteria, which will first multiply on the wound surface and can then, over time, move deeper into the tissues (Elbright, 2005). Bacterial toxin release destroys local tissue and, once established in the deeper tissues, bacteria can continue to multiply and enter the circulation.

In 102 patients with bacteraemia tracked for five years, Bryan et al (1983) determined PUs caused the bacteraemia in 49% of episodes. The mortality for the groups was 55%, with 51% of these deaths attributed to infection. The findings indicate pressure ulcers are strongly linked to soft tissue infection, which can lead to bacteraemia.

Clinical alertness is important in patients with pressure ulcers because the signs commonly associated with impeding infection are frequently absent in elderly patients or the immunocompromised. Sepsis has been reported to occur in 26%, often in the presence of osteomyelitis (Staas et al, 1991), which was found to occur in 86% of one study population's non-healing category IV pressure ulcers (Deloach et al, 1992).

Topical antimicrobial therapy can be used for mild to moderate infection, with systemic antibiotic therapy used for high-risk patients with serious pressure ulcer infections, including those with spreading cellulitis, osteomyelitis, or bacteraemia.

BURNS

The risk of burn infection corresponds to the depth and extent of the burn, the health and age of the patient, local perfusion of the tissues, and use of systemic antibiotics (Gallagher et al, 2007). For the purposes of this document, it is recommended that full-thickness and deep partial-thickness burns be referred to specialist centres/clinicians for management.

Antimicrobial products are often used to reduce bioburden and the associated risk in superficial partial-thickness burns (Wasiak et al, 2008). The most commonly used is silver, which is known to be effective against fungal and Gram-positive and -negative bacterial infections (Lansdown, 2010). In addition, there is growing evidence for the use of honey (Vandamme et al, 2013) and polyhexamethylene biguanide (Piatkowski et al, 2011) in an antimicrobial capacity.

BPS: APLICATION TO PRACTICE: WOUND INFECTION IN SPECIFIC AETIOLOGIES

Best practice statement	Reason for best practice statement	How to demonstrate best practice
Topical antimicrobial therapy might be broadly beneficial to help maintain leg ulcer colonisation at a level the patient's immune system can manage in certain clinical situations	Leg ulcers can become rapidly colonised and fail to heal or display overt signs of infection, which may interfere with compression treatment	Document the rationale for using topical antimicrobial therapy and develop a care plan to reflect the need for increased observation and progress quantification
Use topical antimicrobial therapy as an adjunct to antibiotic therapy to manage diabetic foot infections, particularly if worried about issues such as antimicrobial resistance or other adverse effects of systemic therapy	Many patients with diabetic foot ulceration will develop infection, which can spread rapidly and, when not managed effectively, can deepen the wound, leading to osteomyelitis, serious soft tissue infection and, potentially, amputation	Promptly identify and manage infection, keeping in mind that many patients with infected diabetic foot ulcers will not present with the classical signs of infection Document rationale for using topical antimicrobial therapy
Treat mild to moderate pressure ulcer infection with topical antimicrobial therapy; use systemic antibiotic therapy for high-risk patients with serious infections, including those with spreading cellulitis, osteomyelitis, or bacteraemia	Pressure ulcers provide a portal of entry for bacteria, as the bacteria will first multiply on the wound surface and can then, over time, move deeper into the tissues, releasing toxins, destroying local tissues and, eventually, multiplying into deeper tissues and entering the circulation	Be clinically alert, as the signs commonly associated with impeding infection in pressure ulcers are frequently absent in elderly patients or the immunocompromised Document rationale for using topical antimicrobial therapy
Use antimicrobial products to reduce bioburden and its associated risk in superficial partial-thickness burns, referring deep partial-thickness and full-thickness burns for specialist management	The risk of burn infection corresponds to the depth and extent of the burn, the health and age of the patient, local perfusion of the tissues, and use of systemic antibiotics	Choose an appropriate topical therapy, such as silver, honey or polyhexamethylene biguanide, and document rationale for initiating therapy and choice of topical agent

SUMMARY AND CONCLUSIONS

Promptly diagnosing and managing infection is vital to avoid complications. Clinicians must be knowledgeable of the signs and symptoms of infection, and those patients in whom these might be subtle or absent. It is imperative that clinicians be aware of the impact of comorbidities, medication and therapies on wound healing and infection. Most wounds are colonised by bacteria (ie contain biofilm) and, yet, the majority are not infected, and healing progresses normally (Angel et al, 2011).

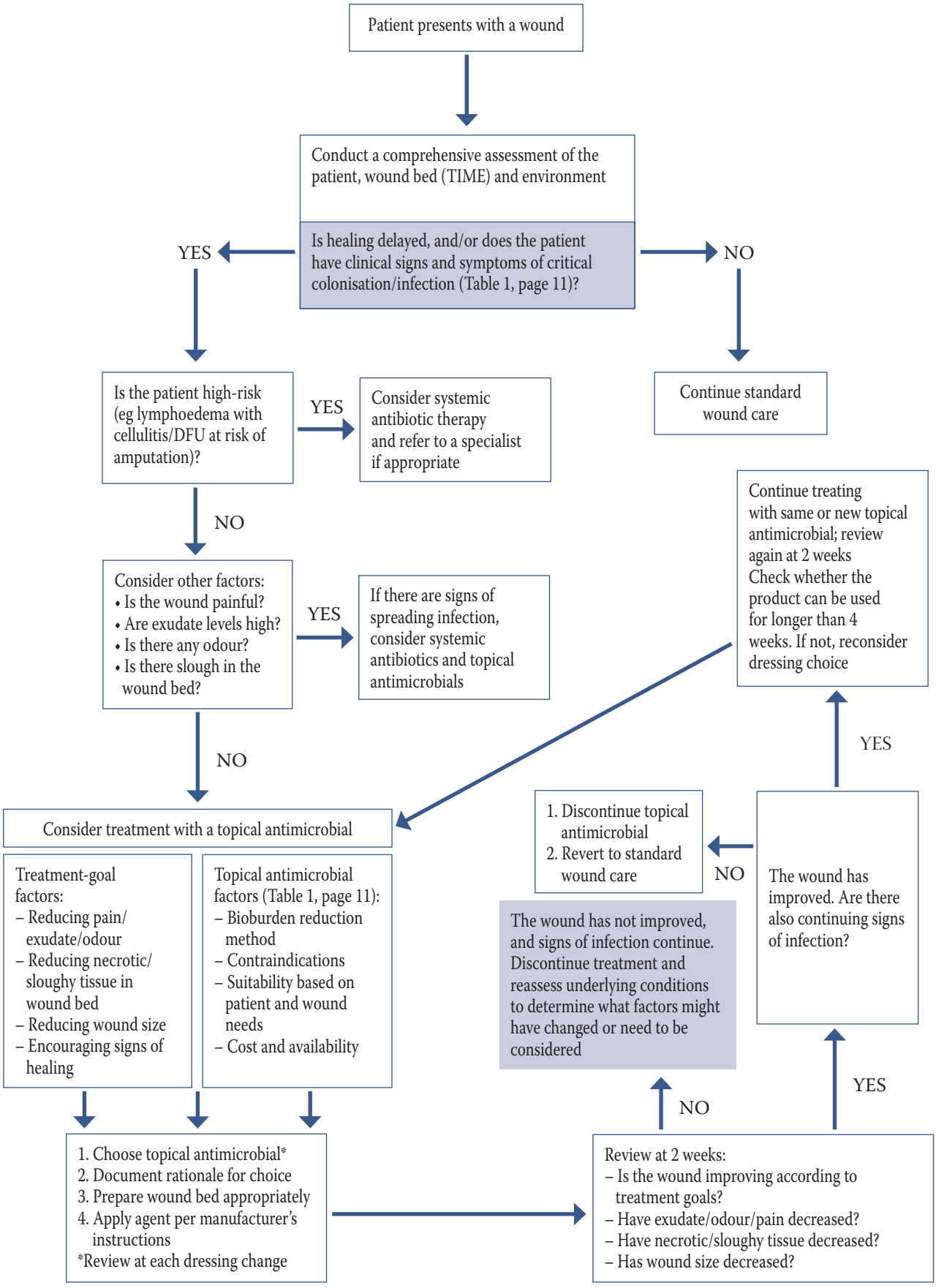
Understanding the correct use of antimicrobial therapy is crucial not only in preventing wound infection but also in promoting wound healing for the patient. All wounds are colonised. Critical colonisation/local infection may can delay healing, cause complications and significantly affect daily living for patients, with increased pain and anxiety, exudate with the potential for leakage and odour. Preventing and managing critical colonisation/local infection is closely linked to quality of care and patient safety (EWMA, 2013a).

Going forward, preventing MRSA bacteraemia through control of MRSA in wounds is also on the government agenda in England. MRSA bacteraemia is being treated essentially as a 'never event' because the policy is zero tolerance — if an orangisation goes over its limit as set by the Department of Health (commonly, the figure is zero cases), a fine will be levied by the commissioners of care (NHS England, 2013). The CCG is also penalised for cases in its commissioning area, as 12.5% of quality premiums will not be paid to the CCG. The full premium can be earned only if no cases of MRSA bacteraemia are assigned to the CCG, and if *C. difficile* cases are at or below defined thresholds for the CCG (NHS England, 2013).

Reducing inappropriate use of antibiotics for wound care will contribute to meeting *C. difficile* and MRSA targets (by not creating further resistance issues) and, therefore, reducing fines levied on providers and helping ensure quality premiums are awarded to CCGs. Using topical antimicrobials appropriately can help prevent selecting for resistant bacteria while promoting factors — such as reduced bioburden — that encourage wound healing.

Appropriate and effective use of topical antimicrobial agents and dressings is important to meeting clinical and patient needs.

APPENDIX 1. DECISION-MAKING ALGORITHM



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