Microbe of the month

Breaking The Chain of Infection

essity

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Newsletter

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Featured in this issue:

Infection In Chronic Wounds –

Best practice principles for the use of topical antimicrobial agents

Many problems associated with the emergence and increasing prevalence of antibiotic resistance have arisen because of the overuse and misuse of antibiotics. Furthermore, resistance to topical agents has also been reported, so if current antimicrobial agents are to remain effective, they must be used responsibly.

The aim of this article is to provide practitioners with an overview of bacterial balance, inflammation and wound infection, and to offer guidance on the assessment of chronic wounds. Easy-to-use clinical criteria for recognizing a high, but superficial bacterial burden versus deep tissue infection will be highlighted in line with antimicrobial stewardship principles on when – and when not – to use topical antimicrobial agents and antibiotics.

Key words: contamination, colonisation, pathogenicity, bacterial burden, antimicrobial, 'NERDS', 'STONES'.

Applied Microbiology

All wounds contain microorganisms, yet the majority are not infected. The ability of a microorganism to cause disease is described as **pathogenicity**, and the capacity of a microorganism to cause harmful effects is known as **virulence**.

Multiple genetic and environmental factors contribute to microbial pathogenicity. In bacteria capable of causing wound infections, specialised structural features, enzyme production and metabolic products contribute to virulence and pathogenicity. For example, the possession of a **cell capsule** (e.g., Pseudomonas aeruginosa and Klebsiella pneumoniae) protects bacteria against phagocytosis by leukocytes or antibody activation.

Fine surface projections ('**pili**') extend from many bacteria (e.g., Pseudomonas aeruginosa and Escherichia coli) allowing attachment to host cells, which is often the first step in the infection process.

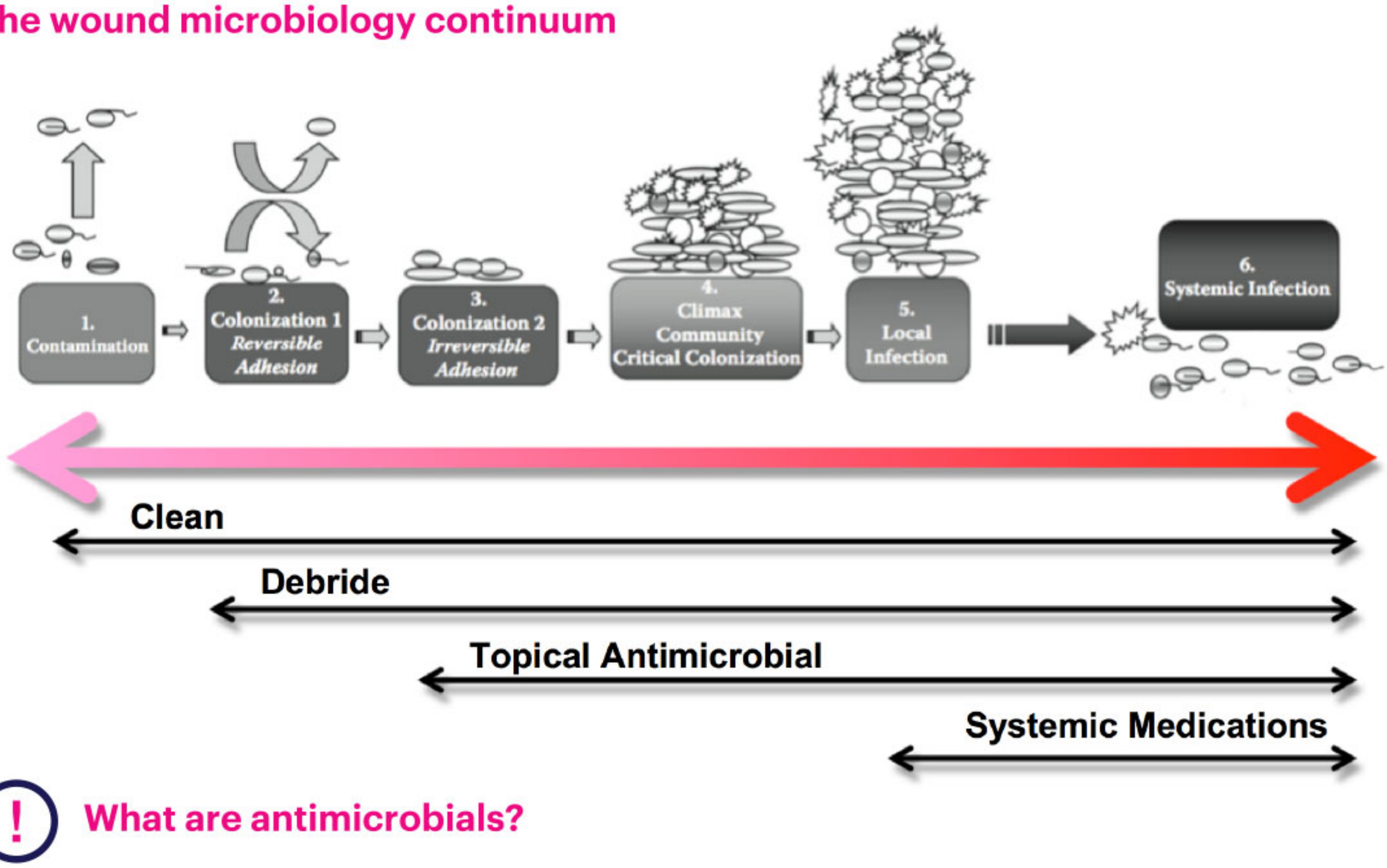
Special **polysaccharides** in the cell wall (e.g., Staphylococcus and Streptococcus species) also facilitate adherence to fibronectin or collagen in the wound tissue.

Many pathogens rely on the production of **enzymes** and **toxins** to invade deep into host tissue. **Exotoxins** are released from living bacteria, while endotoxins are released on microbial cell death and breakdown, causing harmful local and systemic effects.

The interaction between the wound's polymicrobial communities and the host's immune system is a continuum, but it may reach a point at which the healing process is impaired or interrupted. Skilled recognition of when this transition occurs enables the practitioner to initiate topical antimicrobial therapy timeously.

Relevant terms	Wound bioburden and the indications for antimicrobial therapy
Contamination	All wounds have a transient collection of microorganisms. When host defences are adequate, wound healing progresses normally without the need for topical antimicrobial dressing intervention.
Colonisation	There are no signs of infection, erythema, pain or excess exudate. Wound healing should occur successfully without topical antimicrobial intervention, unless there are concerns about the patient's immune system or underlying comorbid conditions.
'Critical colonisation' and superficial, localised infection	Microorganisms multiply until they reach a 'critical mass', and wound healing stalls or deterioration of the wound is clearly evident. Biofilm will begin to alter conditions in the wound and reduce the ability of leukocytes and antibodies to fight infection. Classical clinical signs and symptoms of infection (pain, increased heat, erythema, oedema and purulence) are present. In the absence of these, more subtle local signs, such as changes in the colour of the wound bed or an increase in exudate, may be present.
	The use of topical antiseptics and/or biofilm-reducing agents in combination with antimicrobial dressings is indicated.
Deep compartment and spreading infection	Bacterial numbers increase exponentially, healing is disrupted, and destruction of wound tissue is evident. Besides the clinical signs of wound infection (increased pain, heat, erythema, oedema and purulence) and cellulitis, the patient will experience systemic symptoms such as pyrexia, malaise, raised leukocyte count and/or poor glycaemic control (diabetic patients).
	The use of topical antiseptics, biofilm-reducing agents and antimicrobial dressings is indicated to control bacterial growth. SYSTEMIC ANTIBIOTIC THERAPY WILL ALSO BE REQUIRED.

The wound microbiology continuum



What are antimicrobials?

Antimicrobials are agents that kill microorganisms (bacteria, viruses and fungi) – 'antimicrobial' is an umbrella term which includes disinfectants, antiseptics and antibiotics.

Disinfectants are chemical agents or biocides that are used to inhibit or kill microbes on inanimate objects, such as surfaces and surgical instruments – e.g., 70% alcohol or glutaraldehyde.

Antiseptics, on the other hand, are biocides that are used to inhibit or kill microorganisms present within a wound or on intact skin.

The antimicrobial activity of disinfectants and antiseptics varies widely.These agents are referred to as bactericidal, fungicidal, virucidal or sporicidal when they kill microbes, and bacteriostatic, fungistatic, sporistatic or virustatic if they only inhibit or slow down the growth of microbes.

How do antimicrobial agents work?

Antimicrobials can be applied topically to wounds in the form of solutions, sprays, gels, powders, pastes, creams or ointments, or via a wide variety of impregnated dressing devices where they exert a broad spectrum of non-selective antibacterial action. The method of use and required frequency of application may influence the practicality of a particular antimicrobial agent, while copious exudate production or the presence of slough could also adversely affect its efficacy. Antiseptics act at multiple sites within microbial cells, so fortunately the overall risk of developing bacterial resistance is low. Antibiotics, however, act selectively against bacteria, and their topical use is not recommended for chronic wounds as a fundamental principle of antibiotic stewardship.

Compared with systemic antibiotic therapy, the topical application of antibiotics has many potential disadvantages, including the following:

- There is minimal penetration in wounds with cellulitis or deep compartment infection
- Accurate dosage is not possible
- Systemic absorption is possible in wounds with a large surface area
- Some agents cause local allergic reactions and contact dermatitis
- Frequent applications may be necessary
- Multi-dose containers / tubes become contaminated
- There is the possibility of fibroblast toxicity and delayed wound healing

Properties of the ideal antimicrobial dressing	
Broad spectrum of activity against microorganisms, including resistant strains	Not inhibited by body fluids, exudate or biofilms
	Stable, easy to use and easy to store
Bactericidal and not just bacteriostatic	Assists in wound bed preparation (e.g., moisture management and debridement)
Rapid and sustained activity	
Safe for use on broken skin or mucus membrane	Reduces malodour
Non-cytotoxic to tissue	Conforms to the wound bed
Easily soluble when contained in a carrier dressing	Cost-effective

It is vital to ensure that the benefits of using antimicrobial agents outweigh the potential negative effects on wound healing. For wounds that improve, antimicrobial dressings should be continued for 14–21 days, at which time the need for further antimicrobial therapy should be reassessed.
Note: If a wound fails to respond to treatment, consider another differential diagnosis, such as vasculitis or carcinoma.

Inflammation and the control of infection

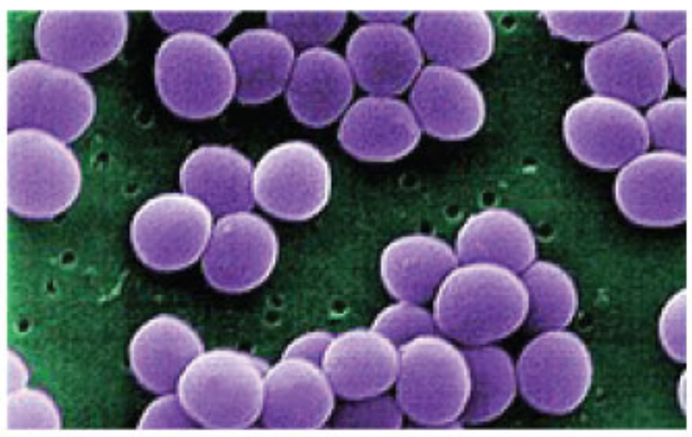
Chronic wounds often stall in the inflammatory stage due to markedly-increased activity of inflammatory cells and associated proteolytic enzymes, such as **matrix metalloproteinases (MMPs) and elastase**. The degradation of extracellular matrix and growth factors occurs more rapidly than their synthesis, hindering the proliferative phase of healing and, ultimately, re-epithelialisation.

Bacteria also make a contribution to the proteolytic wound environment via the production of their own proteases. The production of **bacterial proteases** synergistically enhances the destructive activity of proteases produced by the patient's tissues, further amplifying this hostile wound environment, stalling healing and predisposing the wound to infection.

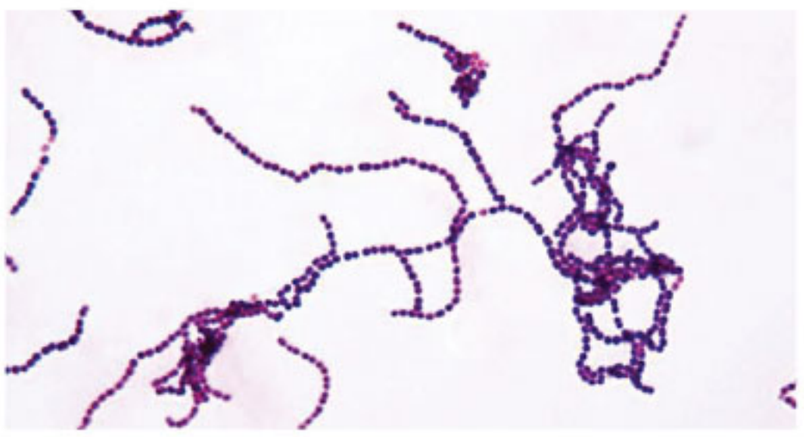
Staphylococci and **Streptococci** are the pathogens most-commonly implicated, although Gram-negative organisms (e.g., **Pseudomonas aeruginosa**) and some anaerobes occur in at least 50% of patients. Diabetic patients are especially at risk because neutrophil and macrophage function is impaired with poor glucose control.

Therefore, it is important to remember that the signs of inflammation and infection may be absent or reduced in diabetic patients due to a poor immune response, ischaemia or severe autonomic neuropathy.

There are wound dressings available made with oxidized regenerated cellulose and collagen, which trap MMPs. These dressings may be combined with antimicrobials (e.g., silver) and used depending on whether the criteria for the mnemonic 'NERDS' (superficial infection and antibacterial dressings indicated) or 'STONES' (deep infection where topical antibacterial agents as well as systemic antibiotic therapy are required) are met. In this way, destructive inflammatory processes inextricably linked with microbial activity can be managed simultaneously within the context of wound bed preparation.



Staphylococcus aureus and its protective cell capsule



Streptococcus pyogenes

Pseudomonas aeruginosa depicting multiple surface pili and flagellae for motility

Maintenance vs. non-healable wounds

A 'maintenance' wound is a wound that may be healable, but healthcare system factors or patient-related issues are preventing the wound from healing.

A 'non-healable' wound is a wound that does not have adequate blood supply to support healing, or a wound in which the underlying cause cannot be corrected.

The use of antibacterial products will be required from time to time on both these wound types to control microbial proliferation. However, the use of moist dressings is not recommended in non-healable wounds, and debridement should be carried out conservatively.

Clinical aids to identify wound infection

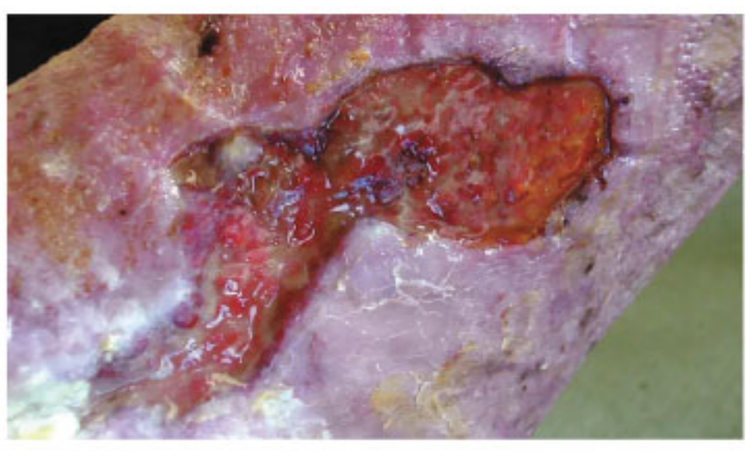
The mnemonics 'NERDS' and 'STONES' represent visual clinical criteria which enable differentiation between two categories of bacterial wound damage or infection.

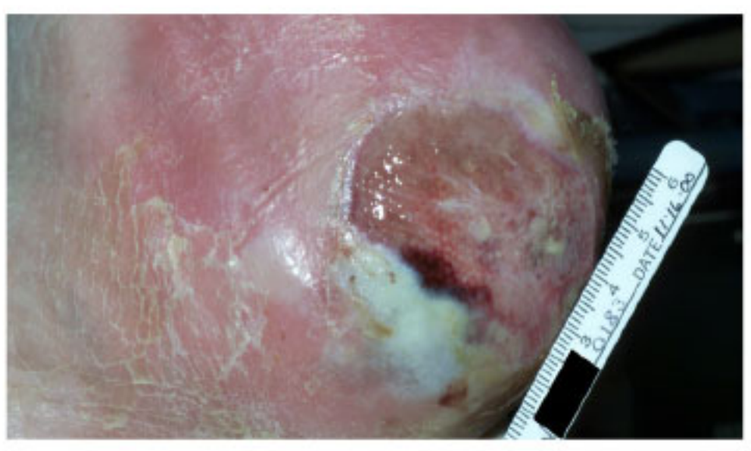
The clinician is able to identify wounds with an increased bacterial burden that may respond to topical antimicrobials, in contrast to deep wound infection which may also require the use of systemic antibiotics. The 'NERDS' and 'STONES' concept was introduced in 2007 and validated in 2009. Three or more of these visual criteria should be sought for the diagnosis in each category.

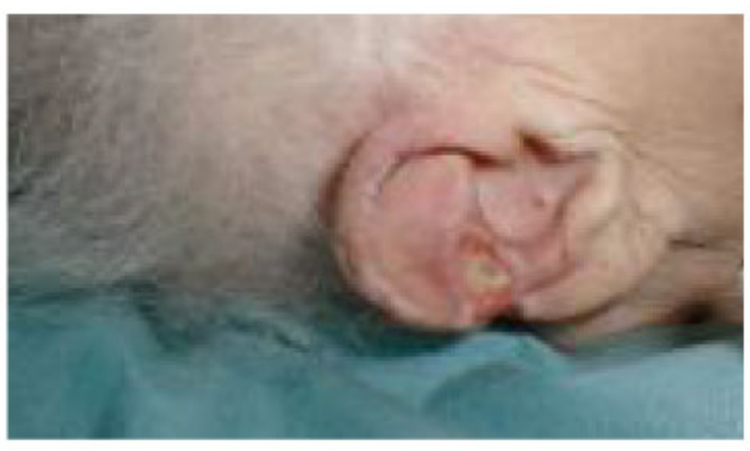
'Critical colonisation' and superficial infection: Think - **'N.E.R.D.S.'**

N	**Non-healing wound**
E	**Exudative wound**
R	**Red, friable granulation tissue**
D	**Debris or slough is visible on the wound bed**
S	**Smell or unpleasant odour from the wound**

The use of topical antiseptics and/or biofilm-reducing agents in combination with antimicrobial dressings is indicated.



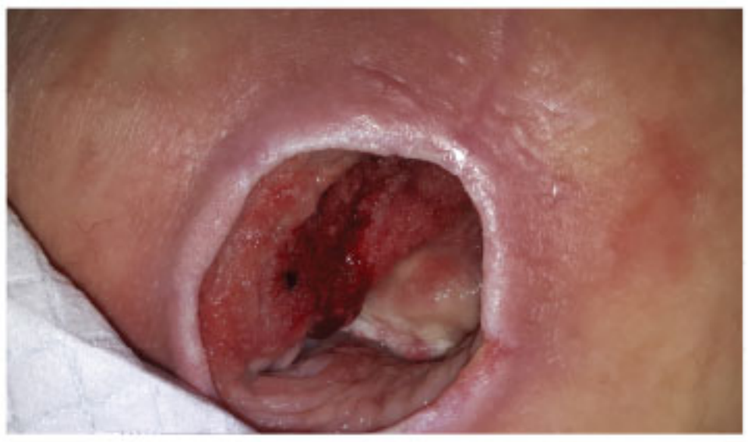


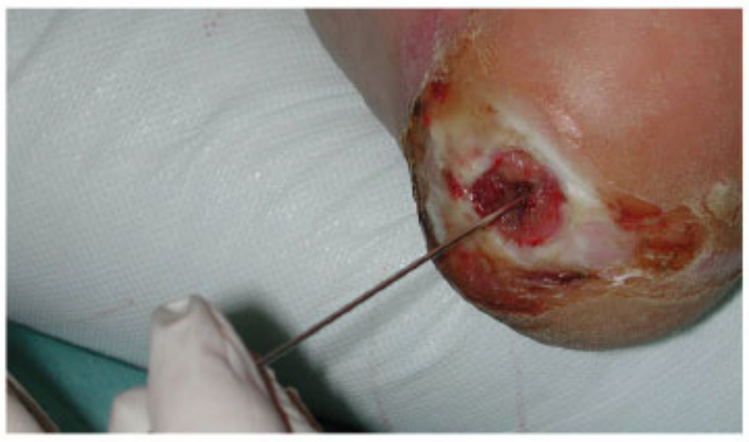


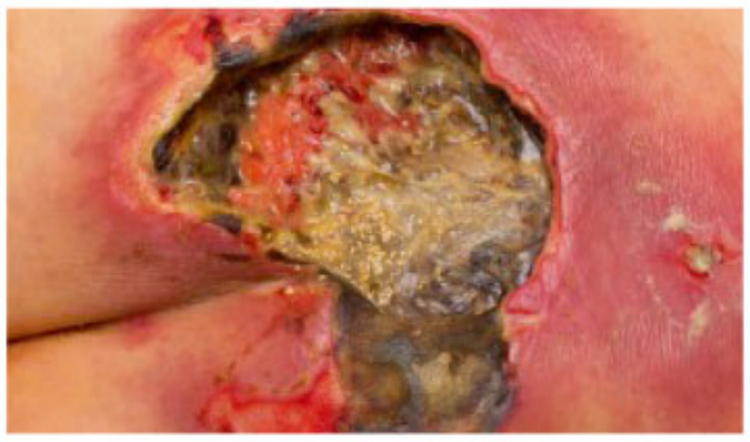
Deep compartment and spreading infection: Think - **'S.T.O.N.E.S.'**

S	**Size of the wound is increasing**
T	**Tissue temperature increased, pyrexia**
O	**Os – probes to bone or bone is exposed**
N	**New satellite areas of breakdown**
E	**Exudative wound, erythema and/or edema**
S	**Smell or unpleasant odour from the wound**

The use of topical antiseptics, biofilm-reducing agents and antimicrobial dressings is indicated to control bacterial growth. Systemic antibiotic therapy is also required.







Key points

- All wounds are colonised. Bacterial populations in chronic wounds are polymicrobial and will usually be representative of regional skin flora and the care environment.
- The development of wound infection is dependent on the pathogenicity and virulence of the microorganism and the immunocompetency of the host.
- It is important to recognise that there is a fluctuating continuum in the wound microbiology lifecycle, and that laboratory culture on its own is not a reliable method for diagnosing wound infection.
- Stalling of the healing process, an unexplained increase in exudate production or failure to heal within the expected time frame may be suggestive of a prolonged inflammatory phase or a high bacterial burden, or both.
- Treatment care plans should be based on the wound bed preparation (WBP) protocol, which includes the control of inflammation, infection, debridement and exudate management.
- A trial period of at least 14 days should be permitted before a decision is made to change the type of topical antimicrobial agent in use.
- If a wound is not 30% smaller by week 4, it is unlikely to heal by week 12. It is important to reassess the treatment plan and consider interdisciplinary involvement to manage comorbidities.
- The care and toilet of the peri-wound skin with antibacterial liquid soap is as important as the care of the wound itself.
- 'Dipstick' urinalysis should be undertaken to exclude asymptomatic urinary infection in patients with poorly-progressing wounds.

In the New Year – an in-depth review of the topical antimicrobial agents commonly used in wound care, as well as evidence-based guidelines on their appropriate selection and use.

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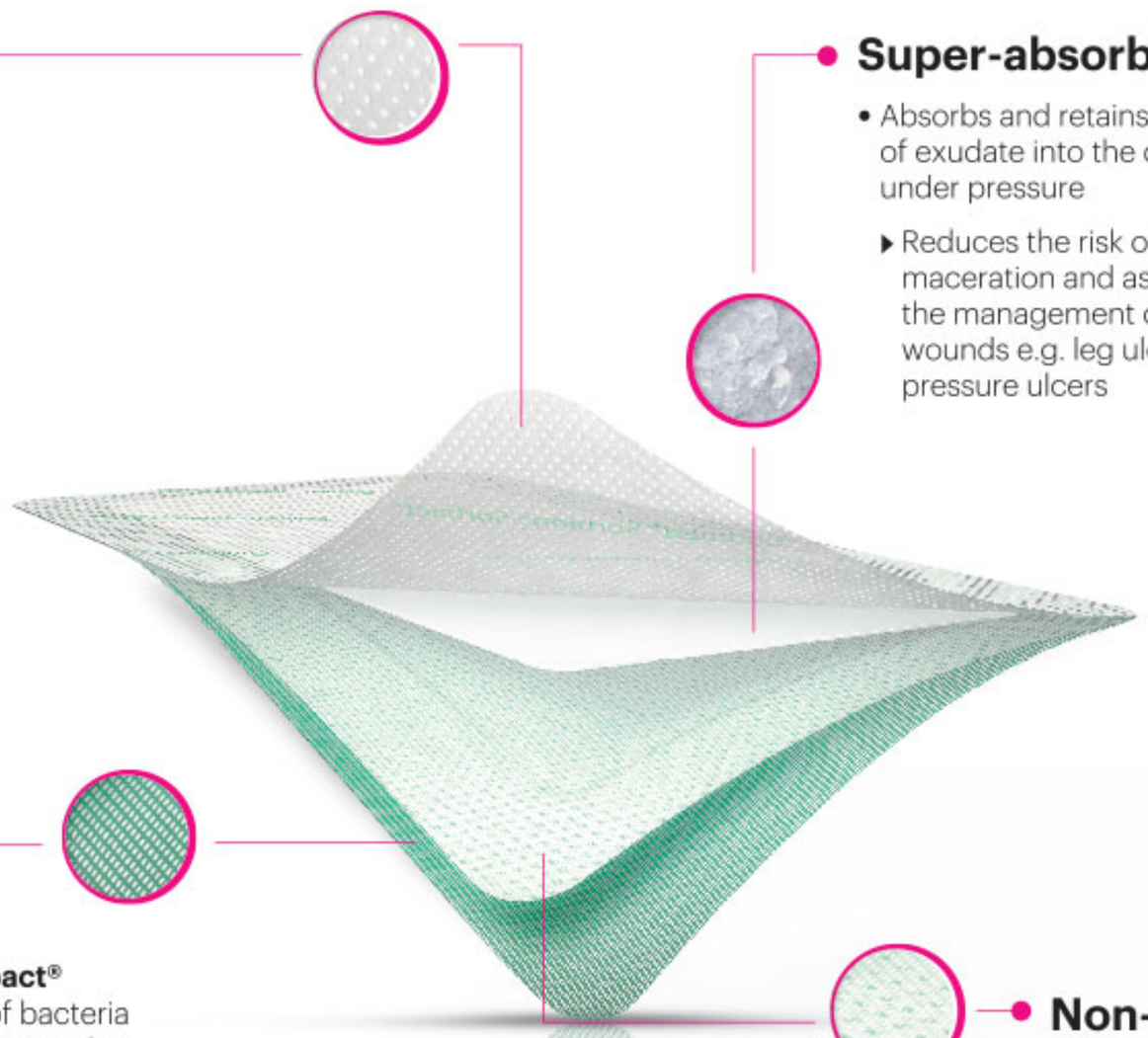

Rounded edges

- Remain flat
  - To provide additional patient comfort

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  - No known risk of bacterial or fungal resistance
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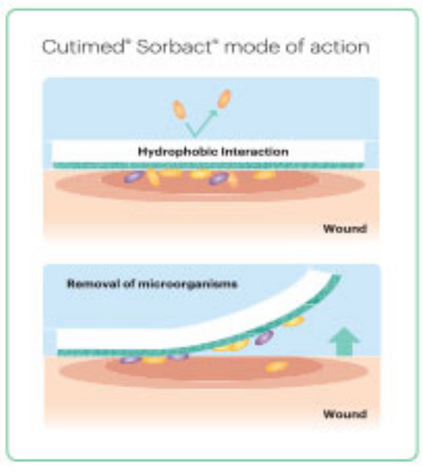
  - Helping to support wound healing
- No contraindications
  - Can be used on all patient groups

Non-woven distribution layer

- Allows for optimal distribution of fluid throughout the dressing and prevents exudate returning to the wound bed
  - Reduces the risk of skin maceration



Ordering Information Cutimed® Sorbion® Sorbact®

Ref-No.	Size	Wound Pad Size	Items per Unit	NAPPI Code
72698-00	10 x 10 cm	8 x 9 cm	10	274714-001
72698-01	10 x 20 cm	7.7 x 17.8 cm	10	274715-001
72698-02	20 x 20 cm	17.8 x 17.8 cm	10	274716-001
72698-03	20 x 30 cm	17.5 x 27.5 cm	10	274717-001

Wound depth Superficial + deep **Wound phase** Infected Sloughy **Exudate level** Moderate to high

[1]Haycocks S, Chadwick P (2011). Use of a DACC coated antimicrobial dressing in people with diabetes and a history of foot ulceration. Wounds UK Vol 6 No 4
[2]Ljungh et al (2006) Using the principle of hydrophobic interaction to bind and remove wound bacteria. Journal of Wound Care, 15 (4): 175 80

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