

# Assessment and management of wound infection: the role of silver

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Every chronic wound plays host to a range of different bacteria. Although most practitioners would feel themselves able to identify frank infection in a wound, there has been a growing recognition in recent years that, depending on the host response to the bacteria, even relatively low levels of bacteria in a wound can have effects on wound healing. There has also been a growing awareness that wound colonization or infection cannot be treated (or dressings selected) in isolation, but must be addressed as part of a holistic approach to wound management. We have therefore seen the development of wound assessment and management tools that aim to help practitioners assess wounds and wound healing in a more critical and nuanced way than has traditionally been the case. In doing so, they aim to help practitioners address barriers to wound healing and provide the optimum conditions for a wound to heal—i.e. wound bed preparation.

Wound bed preparation has become an increasingly accepted term but its implementation within practice

poses some practical challenges. The concept of TIME has been developed by an international advisory panel to offer a structured approach to the implementation of wound bed preparation and the management of chronic wounds (Schultz et al, 2003). TIME incorporates assessment and management (Dowsett and Ayello, 2004) and relates clinical observations and interventions to the cellular level.

- ♦ Tissue—Tissue non viable or deficient
- ♦ Infection—Infection or inflammation
- ♦ Moisture—Moisture imbalance
- ♦ Edge—Edge of wound, non-advancing or undermined.

In clinical practice it is anticipated that this systematic approach will lead to a rational approach to the assessment and management of patients with chronic wounds and, as a result, appropriate dressing selection. Clinicians are encouraged to engage with the classification of the wound bed, to consider the issues of infection/inflammation, moisture balance and maceration and the healing of the edge of the wound.

## Tissue

Determining the viability of the wound bed is essential, however, at present, there is no individual assessment tool available. The wound healing continuum (Figure 1) (Gray et al, 2004) offers a practical approach to categorizing the wound to the most clinically significant colour. This then enables the clinician to appropriately manage the wound and thereby promote healing. Wounds may display several colours simultaneously (a 'rainbow' wound).

## Infection/inflammation

The signs of inflammation are pain, tenderness, redness, erythema, friable, bright-red granulating tissue, increased exudate and possibly odour. When this is prolonged it is indicative of infection (Cutting and White, 2004). Cutting et al (2005) identify the criteria for identifying infection in patients with different types of wounds (European Wound Management Association (EWMA), 2005), and guidance on the management of infected wounds is available from EWMA (2006).

Moist and exuding wounds provide an excellent environment for bacterial colonization and are prone to chronicity and delayed healing (Stout et al, 1998; Bowler, 2003). If there are clinical signs of infection, a culture should be

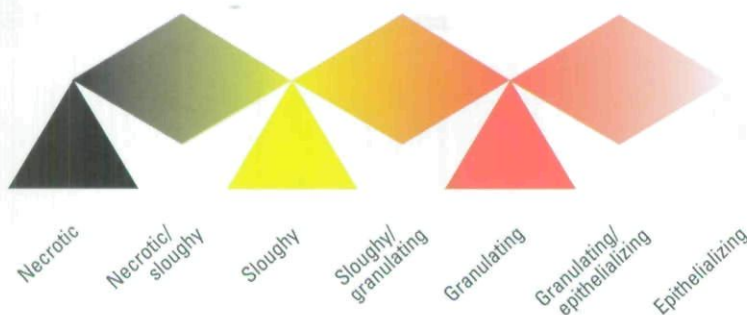


Figure 1. The wound healing continuum (Gray et al, 2004)

## ABSTRACT

The appropriate selection of anti-microbial dressings has become an increasing challenge within clinical practice with an increasing array of dressing availability. A major area of growth has been in dressings containing silver. This article will discuss the rationale for use of silver dressings in the context of wound bed preparation, and offers guidance on their selection and appropriate use.

## KEY WORDS

Wound infection ♦ Colonization ♦ Wound bed preparation ♦ Dressings ♦ Silver

taken, which can determine the surface contamination only and cannot identify the micro-organism responsible for tissue infection.

Infected wounds are detrimental to patients' health, giving rise to an increase in pain and deterioration in the patient's general condition. Clinicians have a professional responsibility to accurately and promptly recognize the signs of infection and to instigate and monitor treatment. Kingsley et al (2004) offer a systematic approach using an infection continuum, with the aim of moving the wound toward colonization; the point at which antimicrobial dressings can play an important role.

The tendency of a wound to become infected—bacteria to proliferate—colonise the wound bed and impair healing, is influenced by:

- ♦ The severity of the lesion
- ♦ The patient's age and state of health, particularly in those with diabetes or anaemia
- ♦ The nutritional status of the patient
- ♦ The ability to mount an immune response (Hambidge, 2001).

There is an increasing emphasis on the rationalization of antibiotic prescribing, particularly when the patient is arterially compromised, which will prevent antibiotics from reaching the wound bed. White (2002) observes that the quantification of microbes representing states of colonization, critical colonization and infection are not exact and are influenced by the host's immune response.

It is essential to be vigilant for signs and symptoms of infection and treat accordingly e.g. following surgery or if a specific risk factor for susceptibility to infection is identified.

- ♦ Leg ulcers are known to be colonised with skin bacteria. The colonisation of wounds does not prevent healing.
- ♦ Infection is a clinical diagnosis based on the presence of clinical signs and symptoms
- ♦ Those with a clinically infected wound require antibiotic therapy either orally or by injection subject to the severity of the infection and the patient's overall state of health

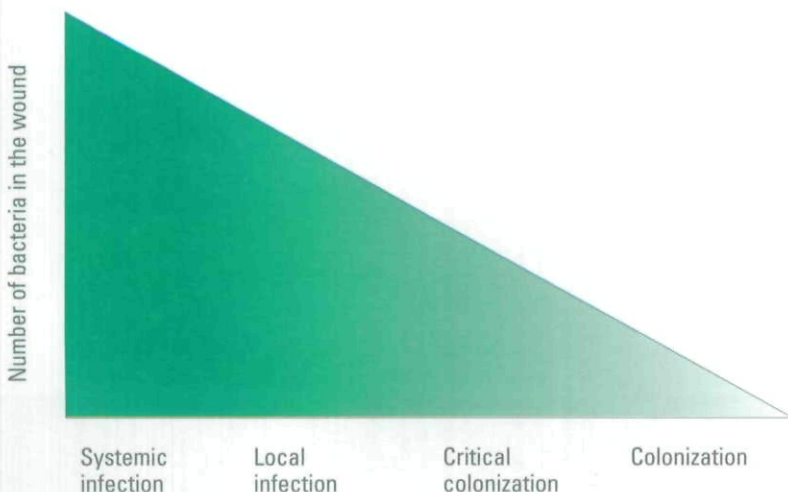


Figure 2. Infection continuum (Kingsley et al, 2004).

- ♦ Wound swabs should only be taken when clinical signs and symptoms of infection are present
- ♦ Antimicrobial wound management products should be considered for use in critically colonised and infected wounds as clinically appropriate
- ♦ Those who are at significant risk of an infection may benefit from the use of an anti-microbial dressing but standard prophylactic use of antimicrobials, like antibiotics, should be avoided (Stephen-Haynes, 2006).
- ♦ Antibiotics are only indicated when there are clinical signs and symptoms of infection, and should be selected on the basis of likely organisms present and/or sensitivities
- ♦ Local consultant microbiologists should be contacted to discuss antibiotic prescribing.
- ♦ Patients should be assessed holistically with particular consideration of underlying illnesses, immune status including anaemia, diabetes, nutrition, pressure reduction, steroid usage and other contributory risk factors. (Stephen-Haynes, 2006)

Healing or the prevention of infection depends much on creating a balance between the host defence mechanisms and the number of pathogenic organisms that occur in the wound environment. Infection in patients with diabetes is increased by the lower oxygen tension, reduced blood supply and disturbed nutrient status in the wound micro-environment (Lansdown, 2003). Universal precautions in infection control should be considered in all aspects of caring for patients with wounds.

## Moisture balance

Management of excessive wound exudates is an important aspect in wound bed preparation (Falanga, 2000). The most significant issue caused by inadequate exudate control is maceration. It has been suggested that this is an under-recognized problem that can postpone healing (White and Cutting, 2003). Maceration appears as white and soggy tissue and can lead to the break-down of the peri-wound area and enlargement of the wound (Cutting and White, 2004). This can lead to a deterioration of quality of life as a consequence of leakage, pain and prolonged healing time (Vowden and Vowden, 2004). Vowden and Vowden (2004) suggest that assessment and management of exudate should include six factors:

- ♦ Cause: systemic, local, wound related
- ♦ Control: whether effective systemic or local control is possible
- ♦ Components: bacterial load, necrotic tissue, chemical composition, pH, viscosity and volume
- ♦ Containment: dressing seal; at the wound surface; within the dressing—away from the wound and skin
- ♦ Correction: control bacterial load (bioburden), debridement, exudate modification
- ♦ Complications: maceration, skin protection, protein loss, pain, odour.

A large amount of exudate or an increase in wound exudate is a recognized indication of infection (Cutting et al, 2005) and clinicians should consider the viscosity as well as the volume of the exudate.

## Edge of wound

The understanding of the processes of granulation and epithelialization has been influenced by recent research into the cellular and molecular environment of the wound bed (Harris et al, 1995). A clearer understanding of the bacterial balance, moisture balance and the role of proteolytic enzymes and pH are increasingly emerging (Greener et al, 2005). Addressing the underlying molecular and cellular imbalance that may be responsible for delayed healing is increasingly recognized as essential in providing high quality wound management in a primary care setting. The non-responsive wound cells and abnormalities in the extracellular matrix and proteases now require consideration in relation to the edge of the wound.

When these cellular deficits are addressed, the edge of the wound will improve. Within clinical practice it is anticipated that this systematic approach will lead to the rational assessment and management of patients with wounds.

## Dressing selection

A vast selection of new dressings, closely tailored to the type of wound to be treated and the particular problems involved have been developed within the last 5 years (Holloway et al, 2002). Dressings can achieve many effects, including: attempting to optimize patient comfort and mobility, manage moderate to severe exudation and excessive fluid production, protect granulation tissue, and manage infections, notably *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Candida albicans* (yeast), *Escherichia coli* and the methicillin and vancomycin-resistant strains of *Staphylococcus aureus*. These organisms present particular problems, including delayed healing and increase in pain. Importantly, almost all these infections are sensitive to silver as an antibiotic and there is accumulating evidence to show that the new sustained-release silver technology is well suited to treating difficult to heal wounds (Lansdown, 2002a,b).

Table 2 lists a range of clinical needs that can be

**Table 1. Clinical need and the use of silver**

Clinical need	Current use silver product	Other alternative
<b>Debridement:</b> Hard, leathery black or dark brown eschar	None	Hydrogel/2nd generation hydrogel Alginate Honey gel Absorbent iodine dressing
Softening yellow brown eschar	Acticoat absorbent Hydrofibre Ag Alginate Ag	Alginate Hydrocolloid Hydrogel sheet/ 2nd generation hydrogel
Sloughy/wet	Acticoat absorbent Hydrofibre Ag Alginate Ag	Hydrocolloid Honey gel Honey tulle Honey alginate
<b>Draining/cleaning sinuses</b>	Acticoat absorbent Hydrofibre Ag Hydroalginate	Capillary dressing Alginate Liquid honey/honey soaked ribbon gauze or honey tulle strips
<b>Cavity management</b>	Acticoat absorbent Hydrofibres Hydroalginate Silver + foam	Alginates foams/hydropolymers Honey alginate –honey/gel/occlusive film dressing Absorbent iodine
<b>Critically colonised wounds</b>	Silver products	Honey alginate or tulle Iodine
<b>Infected wounds</b>	Silver + antibiotics	Honey alginate or tulle with systemic antibiotics Iodine/ absorbent iodine
<b>Overgranulation</b>	Topical steroid silver and iodine dressings; local pressure; foams	Honey tulle
<b>Delayed healing/indolence</b> (no granulation; no edge advancement)	Silver or iodine products;	Honey tulle Protease inhibitors Sharp debridement
<b>Odour control</b>	Metronidazole gel Silver products; charcoal products Silver/ charcoal dressing	Honey tulle or liquid honey honey alginate may maintain its haemostatic properties

addressed using a variety of dressings. It can be seen that while there are silver dressings available for use in a range of situations, there are circumstances that cannot be managed with a silver dressing, or when a non-silver dressing is the appropriate choice.

Silver in its metallic form does not readily work together with tissues of the human body unless in the presence of moisture, and wound exudate where silver ionises to release  $\text{Ag}^+$  or  $\text{Ag}^0$ . Silver and silver compounds have been used as a bactericidal for many years, being broad spectrum and safe.

Correction of the bacterial burden diminishes inflammation in the wound bed, while enhancing proliferative phases of repair (Falanga, 2000). Silver dressings can there-

fore assist in infection control by reducing the number of pathogens to a level where the host is able to provide protection or the level of pathogens is reduced to prevent cross infection. Table 2 lists the currently available silver dressings, their characteristics and practical applications.

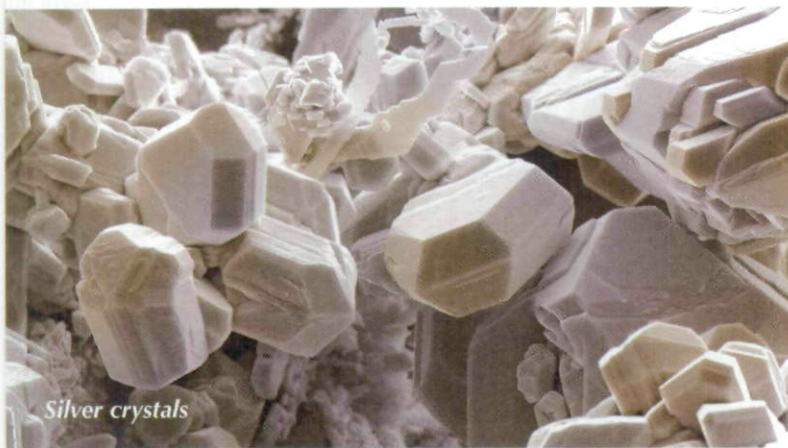
Lansdown (2003) suggests that the efficacy of any silver dressing is dependent upon

- ♦ Patterns of silver ion release
- ♦ The absorption by sensitive bacteria
- ♦ The ability to control the wound environment.

Therefore, consideration should be given to silver as an option and then the type of silver, together with the other requirements of the dressing i.e. absorption, odour control.

**Table 2. Silver dressings for wound care**

Dressing	Composition	Indication and practical use
<b>Acticoat/Acticoat 7</b> (non-adhesive) (Smith & Nephew Healthcare)	Multi-laminate high density polyethylene dressings containing nano-crystalline silver	Partial and full thickness wounds including pressure ulcers, venous ulcers, diabetic ulcers, burns and graft donor sites. Acticoat 7 may be left in place for 7 days.
<b>Acticoat Absorbent</b>	Absorbent dressing with nano-crystalline silver	Silver dressing needs to be activated with sterile water but not saline.
<b>Actisorb Silver 220</b> (non-adhesive) (Johnson & Johnson)	Activated charcoal fabric with 95-98% carbon (carbonised woven viscose rayon material within a nylon sleeve) impregnated with silver	Heavy odorous and infected chronic wounds and ulcers May be folded to fit around wound. Dressing cannot be cut.
<b>Aquacel Ag</b> (ConvaTec Ltd)	Hydrofibre dressing composed of hydrocolloid fibres with silver	Infected wounds Change when saturated or by 7 days. Requires secondary dressing Does not cause staining Overlap wound by 1 cm
<b>Avance/Avance A</b> (adhesive) (Molnlycke)	Self-adhesive hydropolymer dressings composed polyurethane bonded with a silver compound	Exuding wounds and ulcers Dressing may last 7 days
<b>Sorbsan Ag</b> (Unomedical)	Alginate and silver dressing	Change when dressing saturates. Secondary required
<b>Contreet Foam</b> (adhesive or non-adhesive) (Coloplast)	Polyurethane foam dressing impregnated with silver	Moderate to heavy exuding wounds and venous ulcers.
<b>Contreet Hydrocolloid</b> (non-adhesive) (Coloplast)	Hydrocolloid dressing impregnated with silver	Leg ulcers, pressure ulcers, partial thickness burns, donor sites, acute wounds and abrasions
<b>Flamazine</b> (Smith & Nephew Healthcare)	Cream containing 1% sulfadiazine	Silver sulfadiazine has been used since 1968, and as a cream since 1974( Lansdown 2003) Burns, leg ulcers, pressure ulcers Anti-MRSA Caution with renal/ hepatic function Do not apply to surrounding skin as can cause maceration
<b>Silvercel</b> (Johnson & Johnson)	Hydroalginate with silver	For moderate to heavily exuding wounds. Effective against MRSA Sustained release May fold or cut and remove in 1 piece May be left for 7 days
<b>Urgotul SSD</b> (Urgo Ltd)	Polymer wound contact layer impregnated with hydrocolloid particles, petroleum jelly and silver sulfadiazine 3.75%	Use for non-adherence and antimicrobial properties Change every 24-48 hours. May be left for up to 5 days



Silver crystals

Silver dressings should be used until the wound shows signs of healing and limited to 4 weeks if no improvement is noted. A thorough re-assessment should then be undertaken to identify factors that could account for delayed healing. Addressing the underlying molecular and cellular imbalance that may be responsible for delayed healing is increasingly recognized as essential in providing chronic wound care within primary care.

### Implications for practice

The action of silver on the wound is a challenging subject, as Lansdown (2003) observes, with speculation that its action might influence the inflammatory phase, the acidity/pH of wound fluids, connective tissue formation, growth factors, cytokines, and hormonal sensitivities. The anxiety of silver allergy remains a possibility, even though no cases have been recorded in the literature to date (Lansdown, 2003). However, it is worthy of consideration given the emergence of antibiotic resistance making wound infection a challenge in clinical practice.

There is therefore an ever-greater need for the clinician to be educated and updated in relation to assessing and managing wounds. Knowledge of infection control and the use of antimicrobials remains a challenge with emerging evidence rather than absolute evidence. Health care professionals are encouraged to fully utilize any local wound management formulary, which has the explicit aims of:

- ♦ Promoting evidence based practice by providing a

### KEY POINTS

- ♦ Accurate assessment of wounds is fundamental to the facilitation of wound healing
- ♦ Dressings should be selected following a holistic assessment of both the patient and the wound.
- ♦ Silver dressings have an important part to play in the management of infected wounds. However, as with any dressing, their use should be appropriate to both the wound and the patients individual circumstances.
- ♦ New techniques for wound assessment accompanied by holistic assessment.

framework within which it is safe to practice.

- ♦ Promoting continuity of care
- ♦ Promoting rational prescribing
- ♦ Supporting the practical application of nurse prescribing
- ♦ Encouraging safe, effective and appropriate use of dressings
- ♦ Cost effectiveness
- ♦ Local provision of education relating to products within the formulary.

### Conclusion

Chronic and delayed healing wounds including varicose ulcers, diabetic wounds and pressure ulcers are of particular concern. New techniques for wound assessment, the identification of infection and an increasing range of anti-microbial dressings can increase opportunities for clinicians to assist positively with patient care. The publication of clinical trials and experience gained with the new sustained silver release dressings will provide future clarity in relation to the appropriate use of silver dressings.

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