Wound colonization and infection: the role of topical antimicrobials

Richard J White, Rose Cooper, Andrew Kingsley

Intact skin provides a physical barrier to the ingress of microorganisms, but if damaged by wounding, microorganisms from the surrounding skin, other body sites, or from exogenous sources have access to a warm, moist environment. Whether organisms survive and multiply depends on their ability to evade the body's immune system, and whether essential chemical and physical requirements are met.

Wound contaminants may not persist, but those species that do grow and divide may establish either wound colonization or wound infection. The outcome depends on the interaction of complex host and microbial factors (Emmerson, 1998). The size, position and duration of a wound, local perfusion (dissolved oxygen levels) and host immunocompetence are balanced against the number and type of invading microbial species and the presence of foreign bodies (including necrotic tissue and eschar).

The presence of microorganisms in a wound is not unusual, but not all wounds support the same range and number of species (Cooper and Lawrence, 1996a). Elective wounds are usually subject to preoperative antibacterial measures and aseptic surgical techniques, and therefore infection is minimized and healing often proceeds within expected timeframes. Traumatic wounds are more likely to contain devitalized tissue and debris, and to be contaminated with microorganisms from environmental sources; consequently, infection rates are higher.

Chronic wounds, i.e. of over 6 weeks duration (Dale et al, 1983), such as leg ulcers or pressure ulcers are inevitably colonized with a mixture of species and many of these are potential pathogens. The development of infection in chronic wounds often reflects host susceptibility.

Wound infection is one of the most significant factors that delay healing. Although a consensus on the impact of specific microorganisms on the healing process is not yet agreed, the development of infection causes serious delays in healing. Additional consequences for the patient may be increased pain and discomfort, inconvenience and possibly even life-threatening illness. Adverse consequences for the healthcare system may be extended hospital stay, and increased treatment costs in terms of extra antibiotic and dressing usage, together with extra staff costs.

Continued, and often inappropriate, use of systemic and topical antibiotics over the last 50 years has led to the emergence of antibiotic-resistant strains. Both colonized and infected wounds act as a reservoir of potential pathogens that may contribute to increased risks of cross-infection. There is increasing concern among healthcare professionals about the risks associated with the presence of microorganisms in wounds: Do they represent a real risk for cross-infection? Should antimicrobial agents be used? If so, when and how? This article explores some possible answers.

DEFINITIONS

Definitions of commonly used terms in the field of infection control are required to ensure consistency of language, and hence understanding, between authors and readers. The definitions cited in Table 1 are offered for clarification.

Abstract

Infection and bacterial colonization are important factors in compromised wound healing, particularly in chronic wounds. The current 'best practice' for controlling these factors is still unclear. Systemic antibiotics are generally accepted as being the preferred choice for treating infection, provided that ischaemia does not interfere. However, their widespread systemic and topical use is leading to the emergence of resistant bacterial strains such as methicillin-resistant Staphylococcus aureus. Colonization of wounds presents a double problem: possible delayed healing if out of balance with the immune system; and as a source for cross-infection.

Managing colonization is not yet defined in best practice. The judicious use of dressings, notably those containing certain antibiotic agents, can be valuable in infection control and in promoting healing. This review states the case for taking the antiseptic route as part of the concerted approach to local wound management and infection control.

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PREVENTIVE MEASURES

Measures to prevent wound infection and delayed healing situations are based on sound tissue viability principles (Figure 1), which are:

- Identify aetiology of wound
- Remove any continuing intrinsic and extrinsic causative factors such as venous hypertension and shearing pressure
- Eliminate or reduce any factors that may impair healing such as malnutrition, hyperglycaemia and anaemia among others

Infectious therapy at onset; do not use holding or 'wait and see' treatments just because they are more convenient

- Use universal infection control precautions to prevent cross-contamination from the wound
- Remove necrotic and foreign material
- Allow drainage of wound exudate/pus, in particular from sinuses (this does not preclude use of occlusive dressings but does help to determine dressing frequency dependent on the absorbency of the individual product
- Observe closely for signs of change at all dressing changes, in particular those representing a delay in healing or infection
- Construct a care plan that details expected progress so that delays can be detected at the earliest opportunity
- Use a framework to guide decision making for undesired events (Kingsley, 2001)

Modern 'moist wound healing' dressings have been shown to be valuable in infection control. They form part of the non-microbiological approach to control the wound bioburden.

Some occlusive dressings such as hydrocolloids have both bacterial and viral barrier properties. These can be used to 'contain' pathogens within the wound environment, thus reducing the spread and cross-infection (Bowler et al., 1993). Hydrocolloids have also been shown to reduce the airborne distribution of organisms at dressing change through aerosol formation (Lawrence, 1994). In general, occlusive dressings are associated with a lower overall wound infection rate than non-occlusive dressings (Hutchinson and Lawrence, 1991).

Dry dressings such as gauzes stick to the wound. On removal, the traumatic detachment has been demonstrated to spread bacteria by aerosol formation (Lawrence et al., 1992). In hospital clinics this is likely to be a factor in the spread of infections. While there is no evidence that traditional dry dressings have any role in infection control and may even lead to an increased rate of infection, some modern dressings have evidence to support their use in this context.

A hydrofibre dressing, Aquacel (ConvaTec), has been found to bind bacteria and thereby 'contain' the spread of pathogens. In a study using an in vitro wound model seeded with Staphylococcus aureus, Bowler et al. (1999a) have compared a number of fibrous dressings. Results show Aquacel to be most effective in binding the bacteria (P<0.001), followed by the alginates Algosteril (Beiersdorf) and Kaltostat (ConvaTec).

THERAPEUTIC MEASURES

Active steps taken to reduce colonization or counter-infection depend upon the nature of the wound, status of the patient and the pathogenicity of the organism(s) involved. An
There is evidence that the routine use of antibiotics in the management of clinically infected leg ulcers is of no benefit...and there is some evidence that it may be harmful by encouraging the colonization by resistant organisms...Topical antibiotics can provoke delayed hypersensitivity reactions...superinfections...and, more importantly, select for resistance...

**Severity**

<table>
<thead>
<tr>
<th>Sterility</th>
<th>Contamination</th>
<th>Colonization</th>
<th>Critical colonization</th>
<th>Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute wounds</td>
<td>Acute wounds</td>
<td>Acute and chronic wounds</td>
<td>Acute and chronic wounds</td>
<td>Acute and chronic wounds</td>
</tr>
<tr>
<td>Absence of microbes</td>
<td>Presence of microbes but little active growth</td>
<td>Balanced growth and death of microbes</td>
<td>Host defences unable to maintain healthy balance</td>
<td>Host defences overwhelmed, local spread of cellulitis (may lead to bacteraemia, septicaemia and death)</td>
</tr>
<tr>
<td>Very brief period following initial surgical incision or thermal trauma</td>
<td>Present soon after wounding, progresses quickly to colonization</td>
<td>Situation normal</td>
<td>Delay in healing</td>
<td>Exacerbation of wound</td>
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<tr>
<th>No action</th>
<th>Action</th>
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<tr>
<td>Situation will not persist in wounds healing by secondary intention</td>
<td>No need to artificially prevent colonization</td>
<td>Wound healing by secondary intention (with the possible exception of burns)</td>
<td>Do not disturb balance (with the possible exception of diabetic foot ulcers)</td>
<td>Consider using antiseptic dressings to return wound to colonization</td>
</tr>
</tbody>
</table>

*Figure 1. The Infection continuum (Kingsley, 2001).*
The consensus on eusol, especially among nurses, is that it has no place in wound care, regardless of the concentration used... This view is based on evidence that it is rapidly deactivated in the presence of pus, is painful to the patient and delays healing by damaging cells and capillaries...
extensively evaluated in a variety of acute and chronic wounds and found to be safe and effective (Sundberg and Meller, 1997).

The PVP-I containing dressings such as Inadine (a sterile knitted viscose dressing impregnated with 10% PVP-I in a water-soluble base) and Ioban (iodophore incorporated onto a film) provide sustained release of low levels of free iodine. Consequently, this and other modern iodinated dressings should only be used on exuding wounds for best effect.

Iodine is also available as the alcoholic tincture and as Iodoform, neither of which is regarded as being valuable in wound management because of pain and limited bacterial activity respectively.

Silver
Silver and silver compounds have been routinely used as bactericidal for over a century. It is generally recognized as a safe, broad spectrum agent with only irritation and skin discolouration (argyria) reported for the inorganic nitrile solution (Wright et al., 1998a).

Silver acts as a heavy metal by impairing the bacterial electron transport system and some of its DNA functions (Russell and Hugo, 1994; Cervantes and Silver, 1996). To do this, the 'active' agents — silver ions — have to be bioavailable (i.e. to be able to enter the cell), at the correct concentration in solution (Demling and DeSanti, 2001).

Silver nitrate was probably the first silver compound used on wounds where it has an astringent and irritating effect. As a result of these problems it is rarely used today except for the occasional use in reducing hypergranulation. The esterification (chemical bonding) of silver with a sulphonamide antimicrobial — sulphadiazine — (SSD) has resulted in a very safe, broad-spectrum agent for topical use. Silver is released slowly from the oil-in-water cream formulation in concentrations that are selectively toxic to microorganisms such as bacteria (MRSA, gentamicin-resistant Pseudomonas spp. and Enterococcus spp.) and fungi (Goodman and Gilman, 1990).

Best known as the Flamazine 1% cream (Smith & Nephew Healthcare), SSD has been a mainstay of topical burns therapy (Pruitt, 1987) and has been used successfully in acute (Buckley et al., 2000) and chronic wounds (Bishop et al., 1992) to treat infection. Resistance to SSD has been reported (Modak and Fox, 1981) but is rare. A variety of topical silver preparations have been evaluated on chronic wounds (O’Meara et al., 2000, 2001) in controlled trials with favourable results.

Recently, a number of silver-containing dressings have become available (Adams et al., 1999; Furr et al., 1994; Williams, 1994, 1997; Wright et al., 1998a,b; Yin et al., 1999). In any formulation, the way in which silver is incorporated and how it interacts with microorganisms, i.e. its bioavailability in solution, is critical in determining its antimicrobial efficiency and its safety (Demling and DeSanti, 2001).

Actisorb Plus (recently renamed Actisorb Silver 220, Johnson & Johnson Medical) contains silver impregnated onto an activated charcoal cloth (Williams, 1994). It is claimed to be effective against a wide range of microorganisms, although there is only one subjective published report of comparative clinical data (Millward, 1991). Arglaes (Maersk Medical) is available as a slow-release film dressing polymer with silver ions (Williams, 1997). Acticoat Antimicrobial Barrier dressing (Westaim Co. — not yet available in the UK) is an antimicrobial barrier dressing which has also been shown to be effective against a wide range of organisms (Yin et al., 1999).

Although the delivery systems vary, the mode of action principle is the same in each case. There is currently very little clinical evidence available to support these products. Their rationale is based on in vitro studies (Furr et al., 1994; Wright et al., 1998b). Preliminary findings from an in vitro wound model (Bower et al., 2000) suggest that not all can be expected to be equally effective. In heavily exuding wounds, the presence of proteinaceous material in wound fluid is likely to bind to the charcoal layer in Actisorb Silver 220, thus reducing...
The value of cleansing wounds rests with the removal of excess exudate, foreign bodies, including dressing residues, necrotic tissue, loose slough and wound edge crusting (which is fibrin, dehydrated exudate and dressing residue). Removal of all these and leaving the wound moist will ensure that healing will be assisted to progress unhindered.

CLINICAL

The release of silver and thereby reducing the antibacterial activity. These in vivo findings question the capacity of this dressing to inhibit wound bacteria in clinical practice. Products that can sustain the interaction of silver with microorganisms in the exuding wound are likely to be more effective in controlling infection.

Figure 2 illustrates the rationale for iodine and silver dressings in the treatment of critically colonized and infected wounds.

**Proflavine**

Proflavine is an acridine derivative (a compound originally used in the manufacture of dyes) available as Proflavine Cream, British Pharmaceutical Codex (BPC), solution BPC and as the hemisulphate, which has been in use for many years as a slow-acting mildly bacteriostatic (i.e. inhibits bacterial growth) agent in wound management. In particular, proflavine is still widely used prophylactically as a gauze soak for wound packing even though it has been found to be inferior to an alginate dressing in this respect (Gupta et al, 1991). There is no reliable evidence that it is effective in this context, or that it has any clinical benefits. Indeed, there are reports of mutagenicity — gene and chromosomal mutations — of proflavine on bacterial (Iwamoto et al, 1992) and cell cultures (DeMarini et al, 1988), raising questions about its safety.

**Chlorhexidine compounds**

These are useful antiseptics for skin and are highly effective for hand washing and surgical scrub. They bind to the stratum corneum and have a persisting activity, remaining active for at least 6 hours after application (Kaye, 2000). The acetate, Chlorisept (Baxter Healthcare), is intended for wound irrigation. The gluconate is active against Gram-negative organisms such as *P. aeruginosa* and Gram-positive organisms such as *S. aureus* and *Escherichia coli*. Their toxicity and use on wounds has not been established categorically, although they may be a useful therapeutic option as an agent for topical use (Scott Ward and Saffle, 1995).

**Hydrogen peroxide**

Usually used as a 3% (10 volumes) or 6% (20 volumes) aqueous solution to clean necrotic infected wounds, hydrogen peroxide is anti-

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*Johnson and Johnson Medical state that Actisorb Silver 220 is effective for wet or dry wounds (Data on file, Johnson and Johnson Medical, Ascot, Berks)*

septic due to the release of oxygen, an oxidizing agent, on contact with the tissues. There are safety concerns about using hydrogen peroxide solutions on open wounds because of reports of tissue embolism (Scott Ward and Saffle, 1995). Hydrogen peroxide is also available as a 1.5% cream (Hioxyl, Quinoderm) for desloughing wounds.

**Potassium permanganate**

Weak solutions of this oxidizing agent (1 part in 5000, 1 part in 10 000) are used as soaks to cleanse and deodorize eczematous wounds and leg ulcers. Although favoured by dermatologists, there is no evidence published to support their use (Roe and Cullum, 1995).

**WOUND CLEANSING**

The value of cleansing wounds rests with the removal of excess exudate, foreign bodies, including dressing residues, necrotic tissue, loose slough and wound edge crusting (which is fibrin, dehydrated exudate and dressing residue). Removal of all these and leaving the wound moist will ensure that healing will be assisted to progress unhindered. Cleaning that does not seek to achieve any of these aims is unlikely to be of value and is more likely to cause harm by damaging fragile new tissue growth, thereby delaying healing.

However, if one considers wound cleaning to include the periwound skin, then removal of exudate and dressing adhesive residues should reduce the likelihood of maceration, which can extend wounds and excoriation from exudate, enzymes, bacterial toxins and skin pH disturbance (Cutting, 1999).

The ideal method of cleansing depends on the individual circumstances of the case. Some may require rapid sharp debridement under anaesthetic, while in others this may not be suitable and more conservative approaches are needed. Though debridement is technically cleansing, it is usually considered separately.

Normally cleansing is achieved through irrigation with a fluid, or mechanically with a moistened wipe. For wounds healing by secondary intention, the fluid used can be sterile normal saline as it is isotonic but this is expensive in comparison to tap water, which is the fluid of first choice. Studies on traumatic wounds by Hall Angeras et al (1992) suggest there is no quantifiable infection risk with tap
Microbial colonization of open wounds is inevitable and cleansing can lower the bioburden transiently. The purpose of cleansing (whether pressurized or not and with whatever fluid) is to aid removal of necrotic tissues and foreign bodies which provide the medium for overgrowth, a phenomenon which can cause delay in healing.

Wound Dressings

Malodour is common in chronic wounds. It is associated with aerobic and anaerobic bacteria colonizing or infecting the wound (Bowler et al, 1999b). The use of odour-controlling dressings such as those containing charcoal, e.g. Actisorb Silver 220 (Johnson & Johnson Medical), CarboFlex (ConvaTec), Lyofoam C (SSL International), can be very helpful (Thomas et al, 1998a). Indeed, of this category only CarboFlex currently has the capacity to manage exudate (Thomas et al, 1998a) and still control odour effectively (Thomas et al, 1998b). This is attributable to an absorbent wound contact layer that manages the exudate, restricting exudate access to the charcoal absorbent layer. While odour control alone does not eradicate infection or, indeed, alter bacterial growth, it does have substantial patient quality of life benefits and should, therefore, be an adjunct to any topical and/or systemic antibacterial therapy (Haughton and Young, 1995).

The use of modern dressings in infection control shows great promise. Medicated (silver and iodine complexes) dressings can be useful in the local control of bacterial bioburden provided the active agents — silver ions and elemental iodine — are available in solution at an appropriate concentration over time. Such dressings will, in turn, assist in infection control by reducing the numbers of wound pathogens available for cross-infection.

Dressings containing antibiotics generally have a diminishing place in wound treatment primarily because of antibiotic resistance. However, a case can be made for the use of topical metronidazole gel in the palliative treatment of malodorous malignant (fungating) wounds where odour is a major problem and, because of the terminal nature of the disease, antibiotic resistance is not an issue (Rice, 1992).

Chronic Wounds

The detailed reviews conducted by O’Meara et al (2000, 2001) and the Scottish Intercollegiate Guidelines Network (SIGN) (1998) have found little evidence to support the routine use of systemic antibiotics in patients with chronic wounds. Acute infections in chronic wounds should, however, be treated with systemic antibiotics.

Topical dressing creams or ointments that provide a sufficient delivery of an antiseptic agent (e.g. silver or iodine) may be useful. However, the use of povidone-iodine in solution as a wound cleanser is not justified (Leaper, 1994; Burks, 1998). Solutions used as rinses do not have sufficiently long contact time to be of much effect. Cleansers that rely on pressure, as in aerosol sprays of normal saline or containing biocompatible surfactants to help remove necrotic material are effective, but infection control measures must be carefully considered before use.

Surgical Wounds

Clean surgery carries a small (1–5%) risk of postoperative wound infection, whereas ‘dirty procedures’ such as those involving the...
large intestines has a much higher risk (up to 27% (Nichols, 1998).

Minimizing the incidence of infection relies on adequate asepsis, antisepsis and preservation of local host defences (Hunt, 1981). Asepsis involves effective infection control to minimize exogenous contamination during surgery. Antisepsis involves the use of skin antisepsics and prophylactic antibiotics before surgery (Hansis, 1996). Recent guidelines on the prevention of surgical site infection have been published (Mangram, 1999). The emphasis on surgical wound healing is rapid perfusion, as ischaemic tissue heals poorly and is easily infected (Hunt and Hopf, 1997). Healing and resistance to infection improves with increased local blood supply, and hence tissue oxygenation. Delivery of antibiotics, systemically dosed, to the infected wound also depends on perfusion. Antibiotics given at the time of injury will reduce, but not eliminate, the risk of infection.

In one-third of wound infections, bacteria cultured from the wound are susceptible to the prophylactic antibiotic provided. The key factors involved here are patients with hypoxia and local perfusion problems (Hunt and Hopf, 1997). In such instances, it is easy to make a case for prophylactic and therapeutic antisepsics, particularly those provided by sustained dosing from 'medicated' dressings.

The risk assessment for surgical wounds has been defined by the American SENIC study of the effect of nosocomial infection (Study of the Effect of Nosocomial Infection Control) (Haley et al, 1985). This and other factors have been summarized by Kingsley (2001).

DISCUSSION

Antimicrobial agents have been applied to wounds for thousands of years (Moellering, 1995), but the relentless emergence of resistant strains has forced the continued search for novel agents. As each new type of antimicrobial agent has been introduced into clinical practice, changes in microbial sensitivity have been observed. At the outset, there are always some strains that are not inhibited by a new agent (i.e. possess intrinsic resistance), and some species that are susceptible.

Use of a new antimicrobial agent limits the growth of susceptible strains, but eventually resistant strains always emerge. These agents do not induce the formation of resistance genes, but merely provide an environment in which sensitive species are curtailed and resistant species flourish. The emergence of wound pathogens with patterns of multiple antibiotic resistance is having serious consequences in the hospital environment (Morgan, 2000), nursing homes (Fraise et al, 1997), and in the community (Cookson, 2000). The situation is compounded by the increasing costs of searching for new antimicrobials and the decreasing rate of discovery of new agents (Moellering, 1995).

At one time it was considered that the development of resistance to antisepsics and disinfectants was remote, but this has been shown to be incorrect (McDonnell and Russell, 1999). Certain species, such as bacterial spores, mycobacteria and Gram-negative bacteria possess intrinsic resistance, but plasmid-mediated acquired resistance to antisepsics and disinfectants in several bacteria has been reviewed (McDonnell and Russell, 1999).

The presence of different species of microorganisms in the wound has been linked to delayed healing and wound odour. Trengove et al (1996) have found a significantly greater chance of impaired healing when four or more species are present. While the definition of wound infection itself is not accepted unanimously (Gilchrist, 1997b; Leaper, 1998), the consensus is that the signs are recognized as suppurative, cellulitis, lymphangitis, and bacteremia. Many texts refer to a figure of 10^9 organisms per gram of tissue as a criterion for infection (Thompson and Smith, 1994). This growth density, in isolation, has no confirmed connection to the threshold or degree of immune response or to healing (Cooper and Lawrence, 1996b) and none at all if no accurate sampling has been conducted (Robson, 1999).

In 'critical' colonization, the numbers of organisms and of species increases above the levels found in the colonized wound. Clinical signs for critical colonization may be apparent, although primarily it is a microbiological criterion that may only become apparent retrospectively once infection is diagnosed.
time. One implication of these findings is that early and appropriate intervention can avoid progression to critical colonization and to infection, thus potentially improving healing rates and reducing the risk of cross-infection.

Where overt infection exists, systemic antibiotics are usually appropriate for first-line treatment with topical treatments being useful adjuncts, particularly in the case of poor perfusion. Non-healing wounds where critical colonization is suspected or confirmed may also be appropriate for such treatment.

In the case of silver as an antiseptic, the antibacterial action and effects on indolent wounds and burns (Wright et al., 1999) have been established (Demling and DeSanti, 2001). It has been stated that silver can 'provide a disinfected surface in the immediate environment of the wound, thus preventing bacterial infection' (Williams, 1997).

For iodine as anophor or cadexomer preparations, the consensus is in favour of its use in non-healing and infected chronic wounds (Gilchrist, 1997a; Sundberg and McAllister, 1997). Once the infection or critical colonization is reduced and the wound shows signs of healing, it is advisable to change the dressing for one appropriate to the needs of the wound.

Antiseptics and disinfectants have long been the cornerstone of effective infection control and the prevention of hospital-acquired infection. The use of topical silver and iodine containing sustained release formulations on infected and critically colonized wounds can, as part of an holistic approach, be supported. There are several indications for use of a topical antiseptic sustained delivery system, whether it be dressing, cream or ointment:

- **If one or more overt signs of infection, or any less obvious signs such as increased exudate levels, are present**
- **Increased local pain**
- **Cessation of progress in healing, then intervention is indicated to return the wound to health.**

The use of appropriate topical products will also assist in the reduction of odour and local bioburden, thus reducing the risks of cross-infection.
CLINICAL

KEY POINTS

- All wounds should be assessed at each dressing change.
- Where wounds are static, or exude levels high, critical colonization and infection should be suspected.
- Wounds should be cleansed with tap water or saline to remove pus, tissue and dressing debris. Rinsing with antiseptic solutions has no proven clinical value.
- Pre-treatment of the skin with appropriate antiseptics is effective in reducing the risk of surgical wound infection.
- Topical antibiotics are of limited value in treating infected wounds. They should be used only where there is no alternative. Systemic antibiotics, dosed appropriately, are indicated for overt infection with signs of spreading cellulitis.
- Dressings and other delivery systems that deliver sustained doses of effective antimicrobials have been shown to be valuable in the treatment of critical colonization and infection.

Lawrence JC (1998b) A povidone-iodine medicated dressing. Wound Care 7(7): 323-5
Wound colonization and infection: the role of topical antimicrobials

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The ideal antiseptic in wound management has the following properties:
- Broad spectrum of activity, little resistance development, non-toxic, quick effect, not irritating and not sensitizing, effective in the presence of exudate.

PVP-Jod
The use of PVP-Jod is very advantageous through its bacteriostatic and bactericidal effect against MRSA strains. It is undisputed that the use of PVP-Jod in skin antisepsis and its value in wound antisepsis is beneficial in the USA, the Food and Drug Administration recommends the use of PVP-Jod 5-10%, as it is evident that it does not inhibit wound healing.

Silver and Silver Preparations
Silver nitrate can cause irritation. Therefore, it should only be used to reduce hypergranulation. The combination of silver and sulfonamide is known as Flammazine®. Main fields are burns, acute and chronic wounds to treat infections. 1981, however, already resistance to Flammazine® was established.

Wound dressings
Wound dressings with PVP-Jod are recommended for non-healing and infected chronic wounds. When the infection or the critical colonization of the wound is reduced and the wound healing tendencies show, it is time to switch to healing-enhancing measures.

Indications for Antiseptics on Wounds
- Infection
- Local pain
- Wound healing disorder