TECHNOLOGY UPDATE:

Role of wound cleansing in the management of wounds


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Wound cleansing should be seen as an integral part of wound bed preparation to optimise the wound environment by removing debris, reducing bacterial load and preventing biofilm activity. Clinicians have a number of options to choose from when selecting an appropriate wound irrigation solution. Factors to consider include the ability to mount a rapid antimicrobial response to microbial contamination, while avoiding damage to human cells important for wound healing.

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Microorganisms produce significant barriers to the healing of chronic wounds[1]. They are present in all wounds, although not all wounds become chronic. Microbes grow in both a planktonic phenotype (free-floating mobile single cells) and biofilm phenotype (a fixed polymicrobial community)[2]. A self-secreted matrix protects the biofilm from attack by the host immune system and makes the wound harder to treat[3]. In fact, many of the characteristics of chronic wounds such as persistent inflammation[4], exudate[5] and host-cell senescence[6] result directly from biofilm.

Wounds that have become chronic — characterised by delayed or stalled healing — due to suspected biofilm/increased bioburden should be managed with a biofilm-based approach to wound care[7]. This means combining wound cleansing/irrigation with debridement and application of topical antimicrobial agents (e.g. wound cleansers and dressings), to facilitate healing[8] by disrupting, removing and preventing the reformation of biofilm.

Importance of wound bed preparation

Wound bed preparation is recognised as having a key role in wound management. The International Advisory Board on Wound Bed Preparation has developed an assessment tool, known by the acronym TIME (T = tissue, non-viable or deficient; I = infection or inflammation; M = moisture imbalance; E = edge of wound, non-advancing or undermined)[9], that sets out the goals of wound bed preparation: removing non-viable tissue, reducing oedema and exudate, reducing the bacterial burden and correcting any abnormalities to promote wound healing[9]. Wound bed preparation offers a structured and systematic approach to assist clinicians when assessing and managing patients with wounds.

Box 1. Definition of wound cleansing

- Remove surface contaminants, loose debris, slough, softened necrosis, microbes and/or remnants of previous dressings from the wound surface and its surrounding skin[10].

Where wound cleansing fits

Wound cleansing [Box 1] can help achieve the goals of wound bed preparation by assisting in removing loose material to create the optimal local conditions for wound healing by removing exudate and other debris. Irrigation is the preferred method of wound cleansing, as it can clear the wound of debris and microbes, while avoiding trauma in the wound bed[11].

A practical strategy for wound bed preparation in chronic wounds is to lightly irrigate the wound before inspection and assessment. Debride any soft, degraded areas of the wound bed, slough or necrotic tissue according to local protocols, and then re-irrigate the wound with a cleansing solution

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Table 1. Key considerations in some common wound irrigation agents	
Saline[11]	■ Low toxicity ■ Limited ability to reduce bacterial load ■ Bacterial growth can occur in an open container within 24 hours
Sterile water[11]	■ Limited ability to reduce bacterial load ■ Readily absorbed by tissues; water toxicity may result when excess volumes are used ■ No longer sterile after opening
Tap water[11,13]	■ Recommended where saline and sterile water are not available ■ Limited ability to reduce bacterial load ■ Microbes, in particular *P. aeuruginosa* can colonise taps and as a result may end up in wounds irrigated in this way
Commercially available products (e.g. foams, soaps, wipes and solutions with surfactants)[11]	■ Remove bacteria with less required force due to surfactant content ■ May be best suited for wounds with adherent cellular debris and biofilm ■ Typically contain preservatives to extend effective shelf life ■ Can be highly cytotoxic to healthy cells and granulating tissue
Povidone iodine[11]	■ Broad-spectrum antimicrobial activity ■ Cytotoxic to healthy cells and granulating tissue in higher-percentage concentrations ■ May irritate periwound skin
Hydrogen peroxide[11]	■ May be cytotoxic to healthy cells and granulating tissue ■ Ineffective in reducing bacterial counts
Polyhexamethylene biguanide (PHMB) 0.1%[14]	■ Also contains betaine, a surfactant, to lift microbes and debris and suspend them in solution to prevent wound recontamination ■ Has an increased ability to penetrate difficult-to-remove coatings, lifting debris, bacteria and biofilm from the wound ■ Broad spectrum of activity against bacteria, viruses and fungi ■ No evidence of resistance
Octenidine[15]	■ Can be used to loosen encrusted dressings in addition to irrigating debris and microbes from the wound bed ■ Contains octenidine dihydrochloride, a preservative, to extend shelf life and a surfactant-like molecule that is effective at infiltrating wounds while being less irritating ■ Shown to prevent and remove the growth of bacterial biofilms
Hypochlorous acid 0.01% [12, 16–22]	■ Broad-spectrum antimicrobial activity ■ Non-irritating, non-sensitising, non-toxic ■ Can be used to loosen encrusted dressings in addition to irrigating loose debris and bacteria from the wound bed ■ Has rapid antimicrobial activity at concentrations safe for human cells

before applying an appropriate dressing, also according to local protocols.

There are several broad categories of solutions that can be used: saline and water, highly reactive solutions, and minimally or non-cytotoxic antimicrobial-containing solutions.

Exploring irrigation solutions

When considering the clinical benefits of wound irrigation and the appropriate agents to use, keep in mind that an ideal wound irrigation solution will provide periodic reduction of bacterial contamination and removal of debris without adversely affecting cellular activities crucial to the wound-healing process[12]. It is therefore important to consider the balance of antimicrobial action and cytotoxicity when choosing a wound irrigation solution *[Table 1]*.

Saline and tap water

Although tap water and saline are not cytotoxic and do not seem to be harmful to wounds[23], these cleansing choices may not actively promote healing, particularly in chronic wounds with biofilm and/or increased bacterial burden[24], indicating that non-antiseptic cleansing does not remove harmful molecules such as matrix metalloproteases and elevated proinflammatory cytokines. These molecules may be present in chronic wounds and delay healing.

Although these agents have been used as standards of non-cytotoxicity[25], neither has significant antimicrobial properties. This means saline is not appropriate for augmenting wound bed preparation in the context of biofilm-based wound care[26] or where wounds are clinically diagnosed as locally infected or at risk of infection. Further, it should be pointed out that even 'safe' tap water can become colonised with viable microbes. In particular, *Pseudomonas* is well-documented in the plumbing systems of healthcare facilities [13,27,28]. Therefore, a cleansing agent with broad-spectrum activity and rapid kill rates (dwell time of 5 to 10 minutes) should be chosen to aid wound bed preparation.

Highly reactive solutions

Solutions such as peroxide and povidone iodine (depending on the carrier and the strength of the povidone iodine) and commercially available products (e.g. alcohol-based cleansers, soaps, foams and wipes) can be particularly cytotoxic[29]. A 2010 Cochrane review suggested that such solutions may do little to control wound bacteria and may in fact interfere with host healing mechanisms[23]. Although they probably do not significantly harm the host, the high level of reactivity is not necessary.

Antimicrobial solutions

Multiple antiseptic agents are available and have been extensively evaluated for cytotoxicity and their biocidal abilities against a broad spectrum of microorganisms, including bacteria and fungus (yeast)[26]. Common cleansing agents such as octenidine and polyhexamethylene biguanide (PHMB) are minimally toxic to host cells when used in low concentrations[30].

Hypochlorous acid is produced by the body's immune cells in response to invading pathogens[31]. It is available as a commercially-prepared wound cleansing solution, which is non-toxic, effective against a broad range of microorganisms and has a rapid kill rate[32,17]. Clinical studies of hypochlorous acid demonstrate improved wound-healing outcomes[32,33].

Rationale for antimicrobial solutions

After a wound has been washed and debrided, exposing microbial cells to the environment, the antimicrobial properties of a cleansing agent can be effective. Because microbes may exist on the wound bed in high numbers, agents stronger than simple saline or tap water may be needed. Antimicrobial solutions can be used as part of the balance in managing wound colonisation, biofilm and/or infection. Non-toxic agents that are effective at low concentrations should be considered when possible.

Antimicrobial solutions have the added benefit of being usable across the spectrum of chronic wounds without resulting in bacterial resistance issues, because they are antiseptic rather than antibiotic. These factors, along with the ability to disrupt and prevent reformation of biofilm/reduce bioburden are ideal properties of an antimicrobial irrigation solution [Figure 1]. As a result, such irrigation solutions may have an important place within the process of chronic wound management.

Summary

Resolving critical colonisation, biofilm and/or infection in a chronic wound is achieved through appropriate wound bed preparation. The goal of wound cleansing is to remove loose material in the wound bed, reduce bacterial load and to assist in the suppression of biofilm.

Cleansing should be tailored according to the goals determined by holistic assessment of the patient and wound, and best practices for irrigation followed [Box 2]. Generally speaking, wounds should be irrigated at every dressing change until visible debris is removed. Cleansing agents may also be useful in removing encrusted dressings in order to lift them and avoid causing trauma to newly formed granulation tissue in the wound bed.

It is critical that the wound cleansing agent does not impair the wound healing process, but is strong enough to remove the protective matrix secreted by microbes attached to the wound (biofilm) and reduce the bioburden.

Clinicians have a number of options when selecting a wound cleansing agent [Figure 1]. Although saline and water have been found by numerous studies to not be harmful to wounds, this feature is not enough in the context of biofilm-based wound care. Other wound cleansers, such as povidone iodine (in higher concentrations), soaps, peroxide and alcohol may be too harsh[37].

The ideal wound irrigation solution should exhibit potent and rapid antimicrobial activity at concentrations that do not damage host cells required for wound healing. Hypochlorous acid, when used in low concentrations, is non-toxic and has a rapid antimicrobial action. The choice of irrigation solution should also reflect the individual requirements of the wound and the patient after thorough holistic assessment[24].

Box 2. Practical tips for wound irrigation

- **Choice of solution:** Base choice on assessment of both the patient (including medical condition and allergies) and the wound (e.g. clinically assessed as critically colonised)[11,34]
- **Method of delivery:** Deliver irrigation based on the needs of the patient (e.g. pain levels) and wound (e.g. fragility of wound and periwound skin)[11,34]
- **Volume of solution:** Volumes of 50–100 ml per centimetre of wound length is the general rule of thumb[35,36]
- **Prevention of cross-contamination:** The clinician should wear personal protective equipment. Do not use solution that has been opened for longer than 24 hours[11,34]
- **Comfort of patient:** Make sure irrigation solution is at room temperature or slightly warmer. Use analgesia for painful wounds and allow time for it to take effect[11,34]
- **Irrigation of wound:** Position the patient so the solution runs from the upper end of the wound downward or from clean to dirty (if the upper end is heavily infected and the lower end is clean), into a clean basin or irrigating pouch[11,34]
- **Documentation of treatment:** Record all aspects of the wound cleansing, including assessment of the wound (e.g. slough, exudate, pain, erythema), date and time of treatment, amount and type of solution used, skin care performed, wound dressing(s) applied and notes on the patient's concordance with treatment[11,34]

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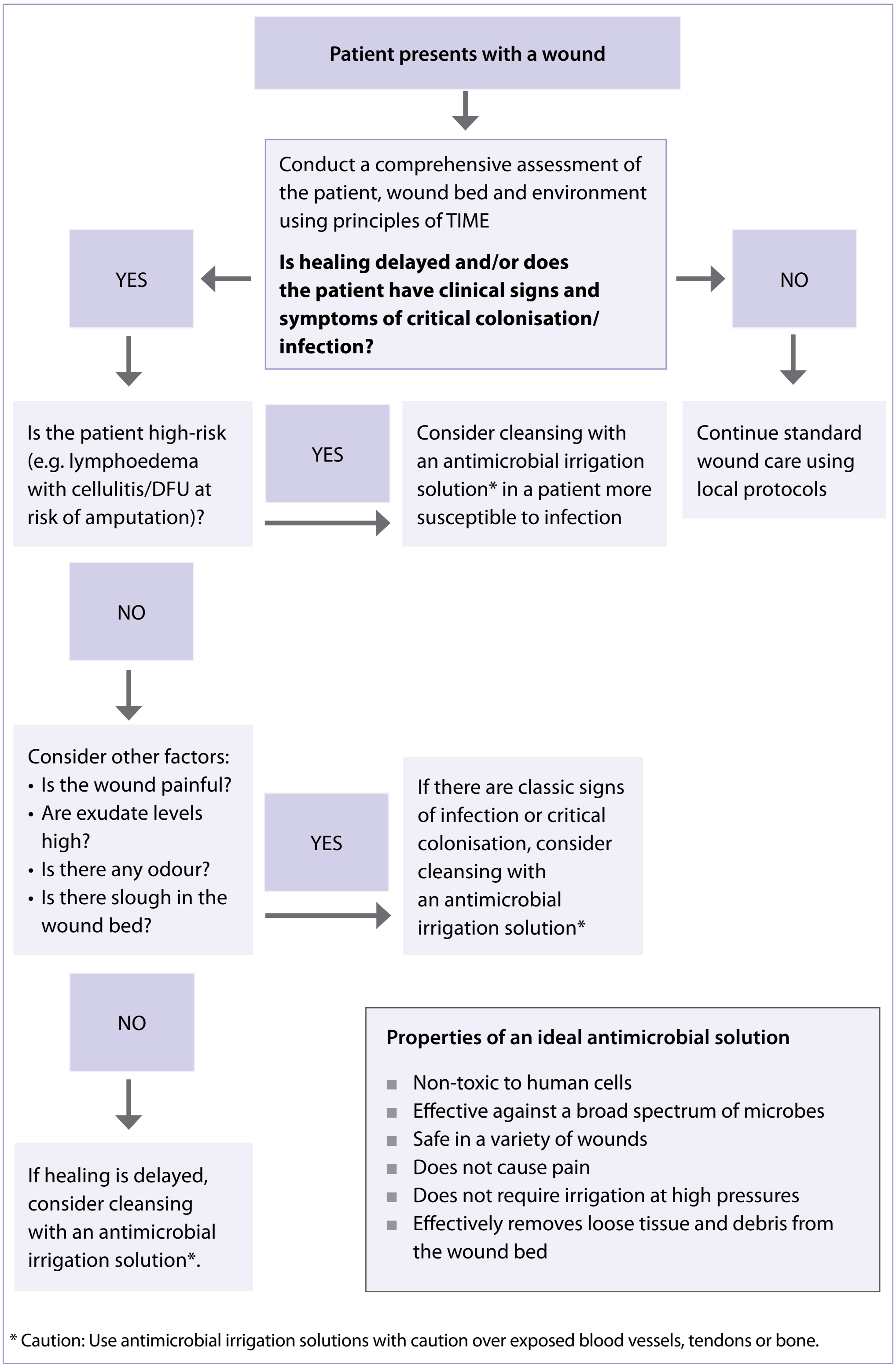

Figure 1. Wound cleansing decision making pathway.

Where holistic assessment leads to the suspicion that bioburden is delaying wound healing, clinicians should consider using a suitable antimicrobial wound irrigation solution to promote healing, reduce bioburden, prevent the proliferation of biofilms and/or remove biofilm before applying an appropriate dressing. As such, cleansing should become an integral part of wound bed preparation, to help prevent infection and optimise the wound environment for healing.

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Expert Commentary: Wound cleansing

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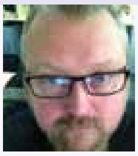

The microbiological profile of chronic wounds is diverse, and Wolcott and Fletcher highlight the developing evidence base regarding the role of planktonic and biofilm phenotypes in the pathogenesis of chronic wound infection[1, 2]. They go on to highlight the fundamental point that increased proliferation of exogenous microorganisms exacerbates a state believed to inhibit wound healing[3].

It is therefore logical to focus on the importance of reducing the microbial load and preventing the introduction of new microbes during management of chronic wounds. Historically, aseptic technique has been mandated to achieve these ends; however, the term is rarely adequately defined, nor is the practical application adequately explained. As a result, practice standards vary widely[4–6], ultimately contributing to failures in aseptic technique and, in turn, contributing to the existence of chronic wounds.

However, having a standard approach to aseptic technique is increasingly mandated internationally[7,8], as it has been shown to improve healthcare worker knowledge and clinical practice and, in a growing number of cases, play a significant role in reducing healthcare-associated infection[9]. One example of a robust, evidence-based clinical practice framework that has improved competency-based teaching and the practice of aseptic technique is the now globally recognised Aseptic Non-Touch Technique (ANTT) initiative[10].

Wolcott and Fletcher attempt to thoroughly address one component of the overall practice of aseptic technique: the importance of delivering effective wound irrigation. In exploring the variety of potential solutions that could be employed in this crucial activity, they touch on the controversy that surrounds sterilised saline solutions and tap water for irrigation. The most recent Cochrane review of randomised and quasi-randomised trials reports no evidence that saline and tap water are detrimental to wound healing[11], but nor does it show that these solutions exhibit the antimicrobial effectiveness needed to help manage chronic wounds.

Furthermore, there are possible water source-related problems with using tap water. For example, gram-negative *Pseudomonas* bacteria is a well-reported issue in tap water[12] and, given the potential for biofilm development in healthcare water systems[13], the nature and extent of its presence in chronic wounds should be investigated further. Chronic wounds are not often swabbed, which limits taking an epidemiological approach to biofilm in chronic wounds. Moreover, in community settings (where the majority of chronic wounds are cared for), water quality is not routinely monitored at the point of use, underappreciating the role it might play in the development of gram-negative-rich biofilms.

Although we cannot know the extent of delayed healing of wounds related to tap water, the potential to impede healing combined with the lack of antimicrobial activity on the parts of both tap water and saline mean they cannot be viewed as the most effective options for irrigation of chronic wounds. Clinicians should therefore seek to use a solution that balances antimicrobial activity with minimal cytotoxicity as part of managing wound biofilm. Of course, whatever wound irrigation solution is chosen and used should be done so in accordance with standardised aseptic technique, to decrease the risk of microorganism proliferation. A holistic approach to chronic wound care, incorporating the practical tips provided by Wolcott and Fletcher, is therefore essential to working towards solving the huge problem of chronic wound prevalence. In an area short of gold-standard evidence, Wolcott and Fletcher's appraisal of both the role and application of wound irrigation will be very welcome by practitioners.

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