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Irrigant Options

Antiseptics

- Dilute bleach (i.e., Dakin's solution)

A 0.05% dilution of bleach has been used to flush necrotic wounds.[6] Nevertheless, it is well-known that bleach is toxic to animal cells. In fact, one study found that to allow 50% of keratinocytes and fibroblasts - two types of important wound-healing cells - to survive, bleach had to be diluted 1,145 times.[19] There is also little actual data to prove using a bleach solution is beneficial in wounds. Due to the availability of other antiseptic options, mechanical debridement and systemic antibiotics, bleach is to be avoided in wounds.

- Hydrogen peroxide

Hydrogen peroxide is one irrigant with easy access and low cost, often offered in the first-aid aisle of drug stores. Its bubbling action can be mistaken for cleansing, bacteria-killing activity. Repeated studies have shown hydrogen peroxide to interfere with cell functions and to kill fibroblasts and keratinocytes.[19 20, 21] The bactericidal activity of hydrogen peroxide is not enough to justify the damage it can do within wounds. For this reason, it is not an appropriate irrigant. It can be used, though, to remove blood and organic debris from intact skin surfaces.

- Acetic acid

Acetic acid, commonly known as vinegar, may be one of the oldest used antiseptics. It is usually diluted to a 1-5% concentration when used as an irrigant. A couple of studies suggest that acetic acid, when compared to other widely-used antiseptics, has equal or greater activity against *Pseudomonas aeruginosa, Proteus vulgaris* and *Acinetobacter baumannii.*[15] Due to its low pH it is toxic to host tissue to some degree. Thus, it should be reserved for wounds infected with the aforementioned organisms in which other antiseptics are failing. When it is used, a 15 min/day compress or soak is recommended, rather than flushing action.[6]

- Povidone-iodine, 0.02% (e.g., Betadine®)

Povidone-iodine is an irrigant over which there is heavy debate. Recent studies imply that while it does have good antiseptic activity, it may also harm tissues and delay wound healing. Three recent studies proved that when used at standard, bactericidal concentrations, povidone-iodine reduced fibroblast migration and proliferation and was toxic to both fibroblasts and keratinocytes.[13, 20, 21] Piagessi et al. looked at the healing times of diabetic foot ulcers, which are excellent examples of chronic, difficult-to-heal wounds. One group was treated with povidone-iodine and another was treated with a super-oxide solution. Povidone-iodine-treated wounds had a healing time 1.5 times longer than wounds treated with the super-oxide solution.[14]

Unless solid research can refute povidone-iodine's apparent tissue toxicities, it should be reserved for use in infected wounds unresponsive to other treatments and intact tissues, such as the skin around wounds.

- Chlorhexidine (4% and 0.05%)

Similar to povidone-iodine, chlorhexidine is steeped in differing opinions and research. Its effects on healing tissue has increasingly come into question.[12]

Chlorhexidine comes in two concentrations: 4% and 0.05%. Chlorhexidine 4% is intended for use on intact skin for scrubbing surgical sites and cleaning hands in preparation for sterile procedures. It is not intended as a wound irrigant.

Chlorhexidine 0.05% is the concentration used for irrigation. Its antiseptic activity has been long studied. Traditionally, it has been thought of as one of the least tissue-toxic antiseptics available. This has lead to its almost ritualistic use in all wounds.

Chlorhexidine has a well-established toxicity to the cornea of the eye, synovial membranes, the middle ear and components of the nervous system. Research in the past decade suggests that even appropriately dilute chlorhexidine may be toxic to other tissues as well. In one study, it had to be diluted times 12 to kill no more than 50% of keratinocytes and fibroblasts.[19] Another *in vivo* study on the chorio-allantois of chicken eggs showed chlorhexidine to be the most toxic of several antiseptics investigated.[8]

The fact that chlorhexidine is toxic towards these cells in a laboratory setting does not necessarily indicate it has similar effects clinically. A study in 1992 examining wounds in six dogs suggested that irrigation with chlorhexidine led to the same healing times as irrigation with lactated-ringers solution.[11] Results from such a small sample size cannot be a sole guide for all clinical choices made. Examining the study from a different angle, the results imply that use of chlorhexidine does not necessarily improve wound healing over the use of saline. More and more, many veterinary surgeons are moving towards reserving chlorhexidine as an irrigant for visibly infected wounds. When it is used, special care should be taken to ensure it has been diluted appropriately.

- Polyhexanid solutions (e.g., Lavanid™)

Polyhexanid solutions are marketed as irrigants for cleaning, moistening and decontaminating chronic skin wounds. A series of case studies in chronic human wounds showed improvement in 70% of patients when irrigation with a polyhexanid solution was started. Improvement was demonstrated by decreased biofilm, less exudate, shrinking dimensions of the wound and decreased pain according to the patients.[7]

Additional studies using the chorioallantoic membrane of chicken eggs as a model for blood vessels, a polyhexanid solution had an irritation score of 0, even after 60 minutes contact time, demonstrating the least toxicity of all antiseptics studied.[8, 13] Furthermore, polyhexanid solutions were found to have antiseptic activity comparable to chlorhexidine and povidone-iodine.[5, 9] It was also seen that while the polyhexanid solution had reasonable antiseptic activity with lower contact times (i.e. 5 minutes), it was the most effective antiseptic when contact time was longer.[9] This time-dependent efficacy again suggests that polyhexanide solutions have the potential to be extremely useful in chronically infected wounds.

- Super-oxide solutions (e.g., Microcyn™ and Veteracyn™)

Super-oxide solutions (SOS's) were initially acidic solutions developed for disinfection of surfaces. They work by inciting oxidative damage. Their activity includes many gram-positive and –negative bacteria, fungi, and several spores and viruses. SOS's demonstrated even faster bactericidal effects than chlorhexidine, working effectively within 30 seconds of contact.[10, 18]

Because acidic solutions can damage tissues, a new generation of neutral-pH SOS's were developed for use in wounds. One paper reports that SOS's left at least 75% of animal cells viable after prolonged contact.[4] In addition to causing cell death, it was feared that SOS's could have the potential to damage DNA and RNA and accelerate cell aging. Gonzalez-Espinosa et al. found this to not be true *in vitro*.[4]

A very persuasive study of diabetic wounds healing by secondary intention found that those irrigated with an SOS had three-quarters the healing time of those irrigated with povidone-iodine.[14] This *in vivo* data combined with the fast activity of SOS's suggests that they could be useful for irrigation of both acute, contaminated wounds and chronic, infected wounds.

<u>Non-antiseptics</u>

- Water

Because of its easy access, water has long been used as an irrigant. A few studies have shown that it can decrease the bacterial load of wounds; this is most likely due to the physical action of irrigating.[17] As innocuous as it seems, water can cause host-cell swelling because it doesn't contain the electrolyte balance of tissue. Since it is desirable to irrigate wounds whenever possible, water appears to be an acceptable irrigant when others are not available.

- Saline (0.9% NaCl) and Lactated-Ringers Solution (LRS)

Saline and LRS are fluids specifically formulated to rehydrate patients via intravenous and subcutaneous administration. They both contain a balance of electrolytes similar to that within cells; saline has a mildly acidic pH when compared to cells.

When compared to antiseptics used for irrigation, saline showed the least toxicity to fibroblasts, keratinocytes and growing blood vessels.[13, 21] Additionally, Sauer et al. noted a decreased "rebound effect" with saline. Immediately following irrigation, it didn't decrease bacterial levels quite as much as the antiseptics used. However, the bacterial load several hours after treatment was lower in those flushed with saline than any flushed with the antiseptics. It was hypothesized that this is due to the tissue damage caused by the antiseptics.[16] Other papers reported it to be one of the only irrigants that didn't damage small blood vessels.[1, 13]

Saline and LRS may be the safest irrigants for newer contaminated wounds and wounds in which the physical act of flushing is the aim.

In conclusion, until further studies directly compare antiseptic and non-antiseptic irrigants *in vivo* in wounds, we are left piecing together bits of research to make the best decision for each individual animal.

Resources

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