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Topical Silver for Infected Wounds

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Clinical Question: What is the clinical evidence base for silver dressings in the management of contaminated and infected acute and chronic wounds?

Data Sources: Investigations were identified by Cochrane Wounds Group Specialized Register (2006), CENTRAL (2006), MEDLINE (2002–2006), EMBASE (2002–2006), CINAHL (2002–2006), and digital dissertations (2006) searches. Product manufacturers were contacted to identify additional eligible studies. The search terms included *wound infection, surgical wound infection, ulcer, wound healing*, and *silver*.

Study Selection: Each study fulfilled the following criteria: (1) The study was a randomized controlled trial of human participants that compared dressings containing silver with any dressings without silver, dressings with other antiseptics, or dressings with different dosages of silver. (2) The participants were aged 18 years and older with contaminated and infected open wounds of any cause. (3) The study had to evaluate the effectiveness of the dressings using an objective measure of healing. No language or publication status restrictions were imposed, and participants could be recruited in any care setting. Studies were excluded if the wounds were ostomies (surgically formed passages).

Data Extraction: Study quality assessment was conducted independently by 3 authors using the Dutch Institute for Health Care Improvement and Dutch Cochrane Centre protocols. Characteristics of the study, participants, interventions, and outcome measures were extracted by one author and verified by a second using a standard form. The principal outcome measure was healing (time to complete healing, rate of change in wound area and volume, number and proportion of wounds healed within trial period). Secondary measures were adverse events (eg, pain, maceration, erythema), dressing leakage, and wound odor. Based on the unique comparisons in the studies, a meta-analysis was not conducted. As a result, summary estimates of treatment effect were calculated for each outcome comparison. RevMan software (version 4.2; Cochrane Centre, Oxford, United Kingdom) was used for statistical analysis.

Main Results: Specific search criteria identified 31 studies for review, of which 3 met the inclusion and exclusion criteria. Lack of randomization and absence of wound infections excluded the majority of studies from the review. In the 3 studies selected, silver-containing dressings were compared with nonsilver dressings and dressings with other antimicrobials. One group used a silver-containing foam dressing and a nonsilver foam dressing; another group used a silver-containing alginate and a nonsilver alginate; and a third group used a silver-containing foam and various dressings (nonsilver foams, alginates, hydrocolloids, and gauze and other antimicrobial dressings). Sample sizes ranged between 99 and 619 participants. Most of the wounds in the included studies were pressure, diabetic, and venous leg ulcers. Wound infection was subjectively defined by 1 group as the presence of 2 or more signs and symptoms (eg, continuous pain, erythema, heat, or moderate to high levels of exudate) and by the other 2 groups as signs of critical colonization (eg, delayed healing, increased pain and exudate levels, discoloration, and odor). The primary measure in the included studies was healing outcome. The 3 groups used various assessments of healing, including relative and absolute reduction in wound area and number of wounds healed during the trial period. The trial period in each study was 4 weeks. In the 3 trials, the authors randomized the participants to the treatment groups.

Examining healing, one group (129 participants) compared Contreet silver foam (Coloplast A/S, Humlebaek, Denmark) with Allevyn foam (Smith & Nephew, St-Laurent, Quebec, Canada). The authors reported no differences for rates of complete healing (risk difference [RD] = 0.00, 95% confidence interval [CI] = −0.09, 0.09) and median wound area reduction (weighted mean difference [WMD] = −0.30 cm^2, 95% CI = −2.92, 2.35). However, Contreet was favored over Allevyn (P = .034) for median relative reduction in wound area (WMD = −15.70 cm^2, 95% CI = −29.5, −1.90). One group (99 participants) compared Silvercel silver alginate (Johnson & Johnson Wound Management, Somerville, NJ) with Algosteril alginate (Johnson & Johnson Wound Management). The authors found no differences in rates of complete healing (RD = 0.00, 95% CI = −0.06, 0.05), mean absolute (WMD = 4.50 cm^2, 95% CI = −0.93, 9.93) and relative wound area reduction (WMD = −0.30 cm^2, 95% CI = −17.08, 16.48), or healing rate per day (week 1 to 4) (WMD = 0.16 cm^2, 95% CI = −0.03, 0.35). One group (619 participants) compared Contreet with various dressings (nonsilver foams, alginates, hydrocolloids, and gauze and other antimicrobial dressings). For median relative wound area reduction, the authors noted a superiority of Contreet over the various dressings (P = .0019).

Examining secondary outcomes, 2 groups used subjective analysis to compare adverse reactions among the dressings. One group reported no difference between Contreet (in satellite ulcers, deterioration of periwound tissue) and Allevyn (in satellite ulcers, maceration, eczema) (RD = 0.02, 95% CI = −0.07, 0.12), and one group found no difference between Silvercel (in pain during dressing change, eczema, periwound erythema, maceration) and Algosteril (in pain during dressing change, eczema, erythema) (RD = −0.01, 95% CI = −0.12, 0.11). Two groups subjectively assessed leakage among silver and nonsilver dressings. The data from one group demonstrated superiority of Contreet over Allevyn (P = .002; RD = −0.30, 95% CI = −0.47, −0.13), and one group found Contreet better than various dressings (eg, nonsilver foams, alginates, hydrocolloids, and gauze, and other antimicrobial dressings) (P = .0005; RD = −0.11, 95% CI = −0.18, −0.05). Using a subjective 4-point scale, one group compared silver and nonsilver dressings and reported a difference favoring Contreet over Allevyn in terms of wound odor (P = .030; RD = −0.19, 95% CI = −0.36, −0.03).

Conclusions: Overall, this review provides no clear evidence to support the use of silver-containing foam and alginate dressings in the management of infected chronic wounds for up to 4 weeks. However, the use of silver foam dressings resulted

in a greater reduction in wound size and more effective control of leakage and odor than did use of nonsilver dressings. Randomized controlled trials using standardized outcome measures and longer follow-up periods are needed to determine the most appropriate dressing for contaminated and infected acute and chronic wounds.

Key Words: antiseptics, moist dressings, critical colonization, contamination

COMMENTARY

Based on the current literature, concern is growing regarding the incidence of infection after acute skin trauma (ie, abrasions, incisions). Inappropriate cleansing, debridement, and dressing techniques and exposure to contaminated sources through common transmission modes (eg, person to person, common source, vector) can lead to bacterial colonization and perhaps clinical infection. From 1992 to 2004, the Centers for Disease Control and Prevention National Nosocomial Infections Surveillance System data[1] demonstrated that surgical site infections were the third most commonly reported nosocomial infection type in US acute-care hospitals. Annually, surgical site infections account for 38% of all infections among surgical patients. In athletes, numerous outbreaks of *Staphylococcus aureus* and *Streptococcus* skin and soft tissue infections have been reported, with acute skin trauma identified as a risk factor. Marketing of solutions, soaps, and dressings used in the management of wound infection has inundated the athletic training product literature and national, state, and local symposiums and meetings. Most advertising efforts have focused on antimicrobial dressings, such as silver, and these marketing strategies have the potential to influence clinical decisions without consideration of existing evidence-based data. Among patients and athletes, a wound infection can increase pain and discomfort, delay healing and return to activities, and potentially cause life-threatening conditions.

Traditional management of a clinical wound infection consists of systemic or local treatments (or both). Silver in the form of topical creams and dressings has been included in local wound treatments. The use of silver as a disinfectant and antiseptic in the prevention and treatment of infection dates back to 1000 BC, and the first silver-containing dressing was introduced in the late 19th century. Silver sulfadiazine, a topical antimicrobial cream, has been used to manage infection in burns for the past 40 years. In response to the growing incidence of wound infection and the morbidity and resistance of causative bacterial strains, production, marketing, and use of silver dressings has increased in recent years.[2,3] Antimicrobial silver dressings contain different concentrations of silver atoms that are released at various rates as positively charged silver cations into the wound bed.[3] The silver ions bind to bacterial cell walls and enzymes, disrupting the wall and preventing cell replication, resulting in bacterial death. Modern silver dressings are used primarily with infected chronic wounds but can be used with contaminated and infected wounds from any source (eg, acute).[2] Among athletic trainers, are silver dressings effective for use in patients and athletes to provide local treatment of colonized and clinically infected wounds?

Vermeulen et al[3] presented only 3 studies comparing silver and nonsilver dressings in the healing of infected chronic wounds. Although these studies met the inclusion criteria, each was a unique comparison with small sample sizes and low power; thus, a meta-analysis could not be conducted. Evidence was insufficient to support the use of silver dressings to increase healing rates of infected chronic wounds. These results corroborate a 2006 Cochrane review[4] on the effects of silver dressings and topical silver among diabetic foot ulcers, in which no studies met inclusion criteria (ie, all had methodologic flaws). Vermeulen et al[3] cautioned against the interpretation of significant findings and stressed the need for additional randomized controlled trials to examine the effects of silver on acute and chronic wound healing. Although the evidence to support the use of silver dressings is minimal, this review offers some clinical implications for athletic trainers and generates questions for future study in the prevention of cross-contamination and management of infection.

The purposes of a wound dressing are to promote healing, reduce pain, contain exudate, provide mechanical protection, and prevent cross-contamination and infection. The goal of silver dressings is to reduce the bacterial bioburden of the colonized or infected wound to a level that allows the individual's host immune response to regain control, as absolute elimination of bacteria is not required for healing.[2] In the review,[3] 2 groups showed that silver foam dressings reduced wound area compared with nonsilver foam and various dressings. This outcome measure demonstrated increased healing favoring silver dressings, but complete wound healing is the most clinically relevant to the patient and was found not to be significant. The reduction in wound area may be attributed to the antimicrobial action of the silver dressings and the reduction of bacterial bioburden, allowing progression of healing. However, none of the 3 groups in the review used duration of infection as an outcome measure. The omission of infection as an outcome measure in these studies is surprising, because a reduction in bacteria is the primary reason for the use of silver dressings.[3] Although the availability and use of silver dressings continue to increase, minimal evidence-based data support or refute the safety and efficacy of these dressings.[5] This indicates that management of infected acute and chronic wounds should be directed by physicians and athletic trainers through systemic antibiotics and the local wound treatments currently used.

Among 2 groups, Vermeulen et al[3] noted a reduction in dressing leakage when silver foam dressings were compared with nonsilver foam and other dressings. The silver foam and the majority of nonsilver dressings described in these studies were occlusive dressings, which are able to absorb excess wound drainage and are impermeable to the release or penetration of microorganisms.[6] These findings indicate that silver foam occlusive dressings are more effective at reducing leakage, further enhancing their impermeability to bacteria by maintaining a secured, watertight barrier, compared with nonsilver occlusive dressings. This action

may lessen the risk of cross-contamination during activity and therapy between those individuals with existing skin trauma and those with wound infections. Additionally, less leakage from wounds covered with occlusive dressings may result in fewer dressing changes, thereby lowering the risk of cross-contamination during cleansing (if required) and dressing reapplication. The results of this review[3] support findings from others[6] that occlusive dressings may reduce the risk of cross-contamination and infection for patients and athletes with existing and infected wounds.

The 3 studies in the review[3] involved chronic wounds (pressure, diabetic, and venous leg ulcers), and extrapolation of these findings to the acute wound environment more commonly managed by athletic trainers can be difficult as a result of cellular, tissue, and bacterial bioburden differences. Based on these differences and insufficient evidence to support the use of silver dressings, further studies are needed. Authors should examine silver dressings in vivo against acute and chronic wounds containing single and multiple microorganisms, biofilms, and debris such as necrotic tissue to determine the effects on bacterial bioburden, bacterial resistance, systemic and cutaneous toxicity, and complete wound healing. Studies to determine the effects on infection of silver in combination with systemic antibiotics as well as studies regarding whether silver dressings can be used to prevent infection in colonized wounds are also warranted. Investigators should identify individual dressing characteristics, such as rate of silver release (type and amount), conformability to the wound bed, duration of dressing wear, adverse reactions, and cost effectiveness, to provide physicians and athletic trainers with the necessary data on which to base clinical decisions regarding infection management.

The review by Vermeulen et al[3] has several limitations that readers should consider in interpreting the findings. Variations in the wounds, dressings, and outcome measures prohibited any meta-analysis, resulting in the absence of high-level evidence to guide treatment. Each of the groups used a 4-week follow-up duration, which contributed to the lack of measurable effects of the dressings. All groups examined healing among infected chronic wounds, an environment characterized by the production of bacterial toxins and waste that inhibit the repair and growth of tissue. This short follow-up duration (4 weeks) and the absence of wound infection as an outcome measure are problematic for investigating the effectiveness of silver dressings, as chronic wounds typically require a longer healing period.[3] Measurements of wound healing also differed among the individual trials, increasing the chance of false-positive results. The 3 trials were financed by single dressing manufacturers, which can affect the objectivity of the results.

In summary, the findings of this review do not support the use of silver dressings to increase healing rates in infected chronic wounds. As a result, infection management should be based on existing systemic and local wound treatments that have been proven effective. More importantly, athletic trainers should focus on preventing cross-contamination and infection through appropriate acute wound cleansing, debridement, and use of occlusive dressing techniques. We need randomized controlled trials on acute and chronic wounds treated with silver dressings to identify their effects on healing, cross-contamination, infection, and patient morbidity. Use of standard outcome measures and blinded assessment should produce the high-level evidence required to guide local wound infection management techniques among athletic trainers.

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