

Wound infection: Silver products and biofilms

Wound Healing and Management Node Group



Denaturing of biofilms is more likely to be maintained through use of elemental silver dressings and sustained release silver products. (Level B)

CLINICAL QUESTION

What is the best available evidence in the effectiveness of topical silver to denature biofilm in wounds??

SUMMARY

Mature microbial cells that form a biofilm in chronic wounds and contribute to poor healing generally have reduced susceptibility to antimicrobial treatment. If full eradication is not achieved with therapy, biofilms quickly re-proliferate.¹ Silver, in the form of salts (e.g. silver nitrate), creams (e.g. silver sulphadiazine) and impregnated wound dressings, has been used widely as an antimicrobial agent in wound management.^{2, 3} Current evidence from in-vitro studies suggests that silver is effective in denaturing existing bacterial biofilm in the long term (7 days) when silver concentration levels at the bacterial site are maintained at greater than 5µg/ml.^{2, 4, 5} However, evidence suggests that silver products may not be as effective as iodine products in denaturing biofilm. Consideration should be given to the environment, patient, wound and local resources when selecting wound management products.⁶

CLINICAL PRACTICE RECOMMENDATIONS

All recommendations should be applied with consideration to the wound, the person, the health professional and the clinical context.

Topical silver impregnated dressings could be used to manage biofilms in chronic wounds. (Level B)

SOURCES OF EVIDENCE

This summary was conducted using methods published by the Joanna Briggs Institute.⁷⁻¹¹ This evidence summary is based on a structured search of the literature combining search terms that describe that describe wound management, biofilm and silver. Inclusion was limited to studies published to October 2012 in English. Levels of evidence for intervention studies are reported in Table 1.

CLINICAL EVIDENCE

Effectiveness in inhibiting development of biofilm

One RCT (n = 36) found that after 4 weeks of treatment, a silver impregnated dressing was significantly more effective (p = 0.013) than a control alginate dressing at reducing the risk of clinical infection (assessed using an index that included development of biofilm) in colonised chronic leg and ulcers and pressure injuries¹² (Level 1).

As other signs of clinical infection also decreased it is likely the inhibition of biofilm development was achieved through the reduction in planktonic bacteria.

Table 1: Sources of evidence and the level

Level 1 Evidence	Level 2 Evidence	Level 3 Evidence	Level 4 Evidence	Level 5 Evidence
Experimental Designs	Quasi-experimental Designs	Observational – Analytic Designs	Observational –Descriptive Studies	Expert Opinion/ Bench Research
1.c RCTs ¹²	None	None	None	5.b Expert consensus ^{3, 13} 5.c <i>in-vivo</i> bench research ^{2, 4, 5, 14, 15}

Effectiveness in denaturing existing bacterial biofilm

One in-vitro study compared the effectiveness of various silver products in denaturing immature biofilms from *S. aureus* strains. Silver sulphadiazine 1% (silver concentration 0.302%) and silver nitrate (silver concentration 0.302%) were associated with a 50 to 100 times reduction in biofilm colonies after 24 hours incubation. Eradication of bacterial film was not achieved¹⁴ (Level 5).

In the same study, no colony reduction was observed in samples of immature biofilms from *S. aureus* exposed to 0.698% sulphadiazine (without silver) and small colony reductions were observed with silver chloride (0.302% silver) exposure¹⁴ (Level 5).

In one in-vitro study, silver sulphadiazine (10µg/ml) was effective in completely eradicating mature *P. aeruginosa* biofilms within 24 hours, as compared with tobramycin (30µg/ml), which had minimal impact on the biofilm colony² (Level 5).

In another in-vitro study the threshold level of silver sulphadiazine for eradication of mature *P. aeruginosa* biofilms was determined to be a silver concentration exceeding 1-5µg/ml, which was over 100 times more concentrated than thresholds to eradicate planktonic bacteria² (Level 5).

An in-vitro study investigating effectiveness of six different silver-impregnated dressings in denaturing *S. aureus* and *P. aeruginosa* biofilms found no reduction in bacterial counts in mature (7 day) biofilms after exposure for 7 days.⁴ However, two of the six different silver-impregnated dressings (nanocrystalline silver and silver impregnated activated charcoal) achieved small reductions in *S. aureus* and *P. aeruginosa* counts in immature (3 day) biofilms after exposure for 7 days. These reductions were less pronounced than those achieved with iodine products⁴ (Level 5).

One in-vitro study found a silver-impregnated dressing to be significantly ($p < 0.0001$) less effective than an iodine-impregnated dressing at eradicating *S. aureus* and *P. aeruginosa* biofilms. In cultures exposed to silver dressings, there was a 3-log reduction in bacterial levels within 8 hours; however bacterial levels increased significantly within the next 24 hours¹⁵ (Level 5).

In another in-vivo study, a nanocrystalline silver-containing dressing maintained a reduction in biofilm bacteria over a 7 day period. In contrast, a silver

carboxymethylcellulose dressing; a metallic silver with alginate dressing; and a metallic silver with starch copolymers on a polyurethane membrane dressing were all associated with an initial decrease in bacterial counts after one day, but this was not sustained over 7 days⁵ (Level 5).

Adverse effects

One literature review presented evidence that high silver concentrations delivered to a wound may have a toxic effect on keratinocytes and fibroblasts and delay reepithelialisation;³ however, other studies did not support this finding¹³ (Level 5).

Topical silver products should not be used for patients with silver sensitivities and silver sulphadiazine products are not recommended for patients with sulphur sensitivities³ (Level 5).

CONSIDERATIONS FOR USE

One in-vitro study identified that the threshold of silver concentration required to eradicate mature bacterial biofilm was higher than concentrations available in most commercial silver-impregnated dressings² (Level 5). To ensure appropriate levels of silver (greater than 5µg/ml or 11mg/cm²) are delivered to the infected wound research recommends:

- Elemental silver dressings (e.g. silver hydroalginate, nanocrystalline silver) generally have higher concentrations of silver than ionic silver dressings (8-20% versus 0.02 to 1.5%) and sustain silver ion release for longer^{4, 5, 16}(Level 5).
- Sustained release products may maintain silver at greater concentrations for longer^{3, 5} (Level 5)
- Consider using dressings with the highest available concentration of silver ions² (Level 5).
- Consider more frequent change of silver impregnated wound dressings in the presence of high exudate² (Level 5).

CONFLICTS OF INTEREST

The author declares no conflicts of interest in accordance with International Committee of Medical Journal Editors (ICMJE) standards.

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ABOUT WHAM EVIDENCE SUMMARIES

WHAM evidence summaries are consistent with methodology published in

Munn Z, Lockwood C, Moola S. The development and use of evidence summaries for point of care information systems: A streamlined rapid review approach, *Worldviews Evid Based Nurs*. 2015;12(3):131-8.

Methods are provided in detail in resources published by the Joanna Briggs Institute as cited in this evidence summary. WHAM evidence summaries undergo peer-review by an international review panel.

WHAM evidence summaries provide a summary of the best available evidence on specific topics and make suggestions that can be used to inform clinical practice. Evidence contained within this summary should be evaluated by appropriately trained professionals with expertise in wound prevention and management, and the evidence should be considered in the context of the individual, the professional, the clinical setting and other relevant clinical information.

PUBLICATION

This evidence summary has been published in:

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