Challenging Silver – Influence of Extraction Medium on the Release of Silver from Commercial Silver Dressings

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Background

- Wound fluid or exudate is a complex mixture of organic and non-organic molecules and ions as well as living and dead cells (host and microbe).
- Most studies of silver in wound dressings measure release into water or high ionic-strength solutions. Less information is available regarding the effect of biological components (e.g. proteins) on silver release from wound dressings.
- Serum albumin is logical choice to represent an organic load. It is the most abundant protein in human plasma.1
- The concentration of protein in chronic wound fluid has been reported to range from 2.6 to 5.1%.2
- Bovine serum albumin is very similar to human serum albumin with respect to both chemical and physical properties.3
- Sample of each dressing (19.6 cm2) placed into 100 ml of simulated wound fluid (SWF; NaCl (142mM), CaCl2 (2.5mM)) at room temperature.
- For seven consecutive days, dressing removed each day and placed into fresh solution.
- Each day, the solution was collected and measured for silver concentration using ICP-OES.

Objective

To analyze release of silver from wound dressings in a medium that simulates proteinaceous wound fluid at a volume to surface area ratio corresponding to a heavily exuding wound over a period of several days. These analyses will allow us to better understand the kinetics of release and the antimicrobial performance of commercial silver dressings during use.

References

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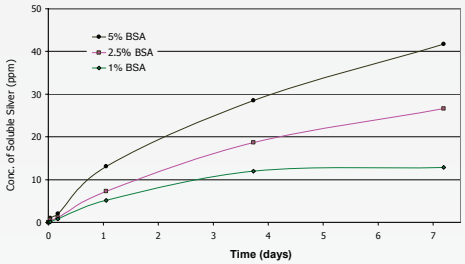
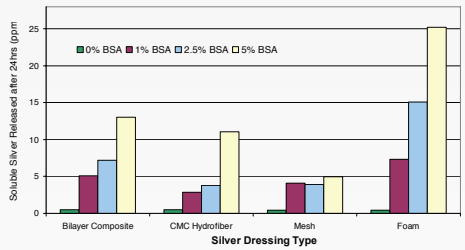
3. Ramat, F.M. “Protein purification using expanded bed chromatography” 2004, Thesis (M.S.); Worcester Polytechnic Institute.
4. Thomas, S., Fear, M., Humphreys, J., Disley, L., Waring, M.J. Wounds 1996; 8:5, 145-150.
5. Cotton, F. A., Wilkinson, G. Advanced Inorganic Chemistry; John Wiley & Sons, New York, 1988; p.94

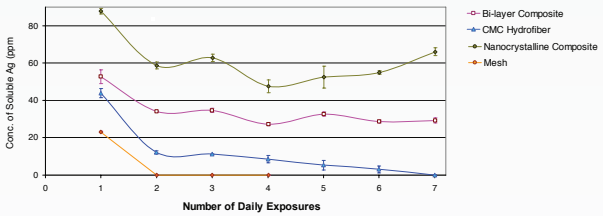
Silver Release in Simulated Wound Fluid with Organic Load

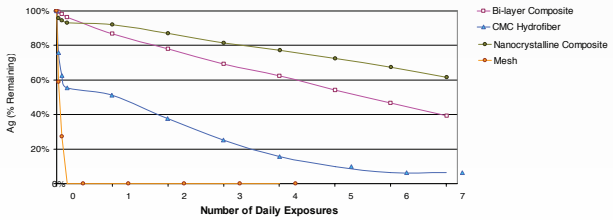
Effects of Protein Concentration on Silver Release





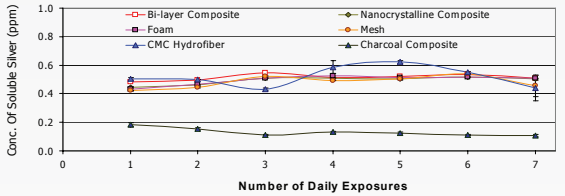
- Sample (19.6 cm2) placed into 100ml of SWF + 1.0, 2.5 or 5.0% BSA at room temperature for several days.
- Throughout the seven days, a sample of the solution was collected and measured for silver concentration using AAS.
- Sample (19.6 cm2) placed into 24g of SWF + 5.0% BSA at room temperature for seven days. Solution was exchanged each day to simulate exudate drainage.
- The dressing area to fluid volume ratio was based on the amount of exudate produced per day from a highly draining venous leg ulcer (1.2g/cm2/24hr).4
- Each day, the solution was collected and measured for silver concentration using AAS.





Silver Release in Simulated Wound Fluid with No Organic Load

- Sample of each dressing (19.6 cm2) placed into 100 ml of simulated wound fluid (SWF; NaCl (142mM), CaCl2 (2.5mM)) at room temperature.
- For seven consecutive days, dressing removed each day and placed into fresh solution.
- Each day, the solution was collected and measured for silver concentration using ICP-OES.
- In SWF with no organic loading, silver release reached an apparent equilibrium at ca. 0.5ppm
- Because of equilibrium, concentration of silver released did not depend on the loading



Conclusions

- In the presence of halides (e.g. Cl-) and absence of biological components, the silver released from most silver dressings peaked at ca. 0.5ppm of soluble silver. One dressing released too little silver to reach the apparent equilibrium level.
- Apparent equilibria established between silver and halide-containing salts (e.g., Cl-) were disrupted by the presence of protein (BSA) resulting in a dramatic increase in silver release over ionic solutions with no protein.
- All dressings tested responded similarly to increasing concentrations of protein regardless of different dressing formats and different forms and amounts of silver.
- It is clear from this study and others previous reports that organics such as protein act as a sink to disrupt and shift the equilibrium of soluble silver. Further studies will focus on the efficacy of released silver from different dressings and whether microbes themselves can act as a sink for silver ions.
- Dressings differed dramatically in the “efficiency” of silver release. The percentage of silver depleted from the dressings after exposure to clinically-relevant amounts of exudates ranged from 100% (silver reservoir was depleted after only one day of exposure) to ≤60% after 7 days.

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