Silver Carboxylate Antimicrobial Shows Ability to Disperse Staphylococcus aureus MW2 Biofilms and Attenuates Viability of Persister Cells

2022 Lifespan Research Day Abstract

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Primary Research Location: Diane Weiss Center for Orthopaedic Trauma Research, Rhode Island Hospital, RI, USA

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Abstract

Background & Aim: Surgical site infections (SSIs) are a main contributor to surgical morbidity and mortality1. This problem is exacerbated by antibiotic−resistant bacteria and biofilms2. Previous efforts have found silver carboxylate (AgCar) released via a titanium dioxide−polydimethyl siloxane (TiO2−PDMS) matrix to be efficacious against antibiotic−resistant bacteria3. While much is known about the antimicrobial properties of silver, little is known about silver carboxylate's ability to combat biofilms and their respective persister cells4. The purpose of this study is to evaluate the ability of silver carboxylate to penetrate and disperse biofilms and eradicate persister cells in a clinical strain of Staphylococcus aureus (S. aureus)5.

Methods: Biofilms were grown overnight on 4mm filter disks in a 24−well plate at 2x108 CFU/ml, and treated with 1x, 10x, 30x, and 300x silver carboxylate in 95% TiO2:PDMS matrix. 100% AgCar served as a positive control. Matrix−only and non−treated cells served as the negative controls. Biofilms were fixed in 10% neutral buffered formalin and stained using TOTO−1 (extracellular DNA), Concanavalin A (exopolysaccharides), and SYPRO (proteins). Images were obtained via an Olympus FV−1000 MPE Multiphoton Microscope and quantified using ImageJ. Persister cell killing assay: Cultures were grown overnight to log phase. 2×108 CFU/mL of S. aureus were subject to 20−fold MIC of gentamicin to generate persister cells and same treatment conditions as above. Aliquots were removed at specific times, serially diluted and spot−plated on Tryptic Soy Agar (TSA) for enumeration.

Results: The 30x silver carboxylate solution showed the greatest reduction in biofilm area as measured by reduced signal intensity of MW2 biofilms. Additionally, the 10x silver carboxylate solution demonstrated a log6 reduction in concentration of persister cells over the 72 hours.

Conclusion: The 30x AgCar demonstrated the highest reduction in biofilm signal intensity, indicating its potential for use as an effective antimicrobial agent. Additionally, the 10x AgCar solution has demonstrated the highest level of persister cell killing, suggesting a potential for alternatives or synergy to antibiotics.

Clinical Implications: Antibiotic resistance is a growing threat throughout medicine. Biofilms and persister cells, in particular, limit antibiotic penetration and efficacy. These results demonstrate that this silver carboxylate−eluting matrix can penetrate biofilms and significantly effect persister cells.