Assessing the Wound Biofilm Efficacy of a Combined Bi-Phasic Strategy: Silver Alginate Dressing and Silver Hydrogel

John G. Thomas, Ph.D.; Will Sloane, BS; Linda Corum, BS, MS; Laura Bradel, BS; WVU School of Dentistry, Morgantown, WV USA 26506
Shepard University, Department of Biology; Shepardstown, WV USA 25443; International Center for Biofilm Studies Linking Disruptive/Restorative Microbial Engineering

SAWC 2

Purpose:

This is a continuation of multi-tiered studies to unmask the intervention in biofilm communities associated with chronic wounds. (Fig. 1) Our Initial studies addressed the 1) significant broad range antibiofilm activity of silver alginate, 2) unmasking of the Ping-Pong Hypothesis, (Fig. 2) and 3) the use of bioluminescence microbes to better define the impact of dressings and silver release on multi species communities .

Most anti-biofilm strategies have focused on single type applications, with limited success, often non-wound conforming dressings. Here, we wanted to assess simultaneous delivery of two silver carriers, recognizing the importance of delivery and plasticity of dressing in a Bi-Phasic strategy

We also wanted to address the collateral damage with infected wounds including the emerging importance of Horizontal Gene Transfer (HGT) as a precursor of Multi Drug Resistance (MDR), a focus of recent CDC highlighted mortality. Our concept was to reduce environmental transmission via barrier (Anti-Planktonic), while increasing silver delivery at the wound site (Silver Saturation) via Anti-Biofilm, recognizing the biofilm as a molecular platform and the growing concern of Persister Cells. (Fig. 3)

Biofilm SEM in Chronic Wound

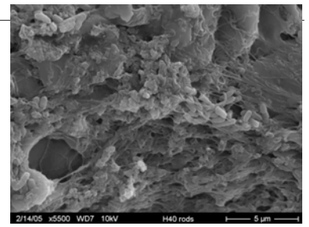

Fig. 1

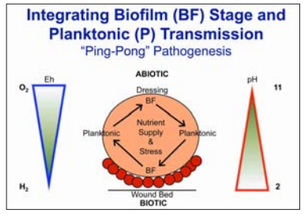

Fig. 2

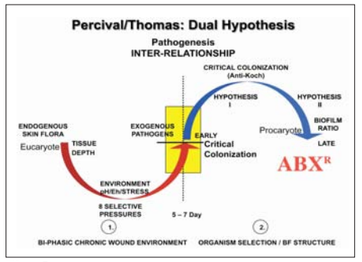

Fig. 3

Method:

We assayed silver alginate and silver gel activity of Vancomycin Resistant Enterococcus (VRE), Methicillin Resistant *Staphylococcus aureus* (MRSA), *E. coli* (Ec), and *Pseudomonas aeruginosa* (Pa) in both planktonic (P) and biofilm (BF) phenotypes, at 12, 24, 36, and 48 hours using Zone of Inhibition (ZOI) of 4 stacked combinations. Organisisms were selected by CDC criteria of "Threat Level of Serious" (Figs. 9, 10, 11) Organisms were grown to 10x6 and applied as an agar overlay. 6-test samples in 1cm squares for biofilm phenotype included: A) alginate dressing no silver; B) silver dressing B; C) silver dressing C; D) silver dressing D; E) alginate dressing, no silver + silver gel; F) silver dressing C + silver gel; G) silver gel alone. Tobramycin disc was antibiotic control used in CLSI approved protocol and Kirby Bower methodology.

The Poloxamer is a biologically inert di-block polymer or reverse gel which induces biofilm formation and Extra Polymeric Substance (EPS) associated with the biofilm phenotypes .

Planktonic (P)

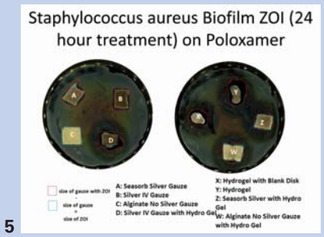

Fig. 5

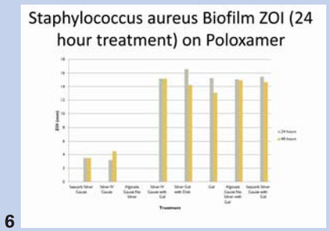

Fig. 6

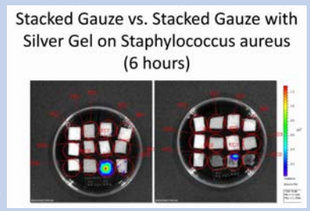

Fig. 7

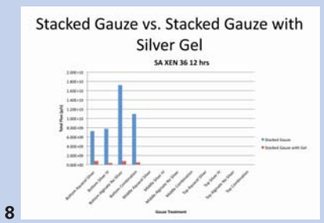

Fig. 8

Results:

With 3 organisms pools, combinations of silver gel and gauze had larger ZOI's (4.5-8.9mm) with MRSA showing largest ZOI with silver gel alone (5.9mm). Silver IV alginate dressing with silver gel had largest ZOI (9.9mm) vs. Pa. Variability in ZOI's (1.1 to 9.6 mm) of alginate dressing with no silver and silver gel emphasized efficacy of dressing type, planktonic (Figs. 5, 6, 7) or biofilm phenotype (Figs. 12-16), and species, with most reduced ZOI vs. MRSA (5.5mm) in biofilm phenotype.

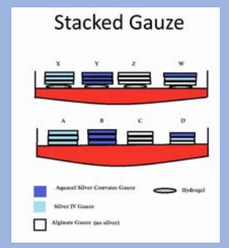

Fig. 9

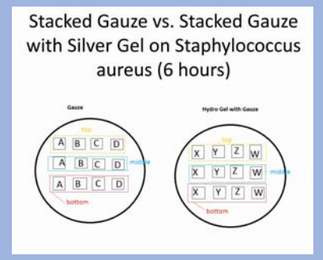

Fig. 10

Fig. 11

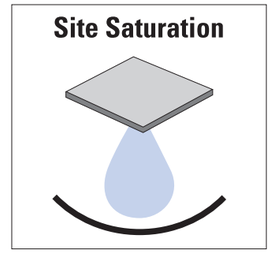

Fig. 4

Biofilm (P BF)

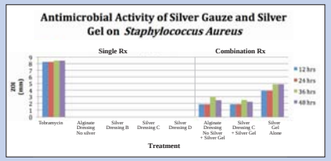

Fig. 12

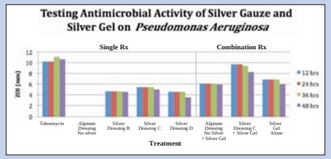

Fig. 13

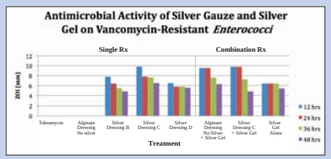

Fig. 14

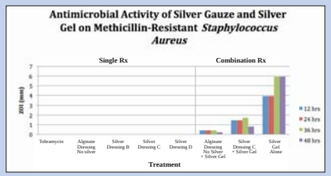

Fig. 15

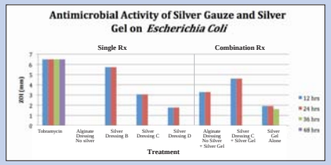

Fig. 16

Conclusion:

A combination of silver Bi-Phasic delivery, utilizing an alginate dressing with gel, had greatest overall efficacy, highlighting the need for wound contact (plasticity) and different silver concentrations.

BIOFILMS "Elephant in the Room"

It also underscored our concept of Site Saturation, a recognized approach in systemic antimicrobials effectively using the highest dose possible early at the infected site.

Finally the strategy also recognizes the dual pathway of wound pathogenicity (Early and Late), based on a Planktonic phenotype transitioning to a Biofilm phenotype, via Critical Colonization. The Bi-Phasic concept addresses the 1) Environment and 2) wound interface and the molecular platform of the biofilm, which should not be allowed to form, reducing HGT and MDR through Persister cells. (Fig. 17)

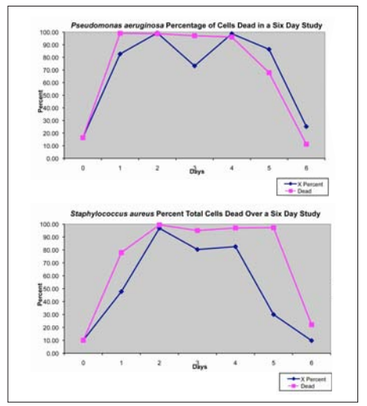

Fig. 17