

2026 MILITARY HEALTH SYSTEM RESEARCH SYMPOSIUM

# Advanced Biofilm-Disruption Methodology for Preventing Surgical Site Infections (SSI) via Synergistic Silver Solution

**Session:** Fighting the Invisible Enemy, Combating Antibiotic Resistant Bacteria in Combat Wounds

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Abstract MHSRS-26-2335 | Oral Presentation

Wednesday, 5 August 2026 | 0800–1000 | Room SUN A

# Disclosure

|                                    |                                                |
|------------------------------------|------------------------------------------------|
| <b>Presenter</b>                   | Eyal Nouri, CEO                                |
| <b>Financial Relationship</b>      | Employee / Co-Owner, Silverstream Medical Ltd. |
| <b>Grant / Research Support</b>    | None                                           |
| <b>Consultant / Advisory Board</b> | None                                           |
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# Learning Objectives

-  Analyze the global clinical and economic burden of surgical site infections, specifically in high-risk and contaminated surgical procedures.
-  Describe the synergistic mechanism of low-concentration silver nitrate and menthol in penetrating wound beds and neutralizing resistant pathogens without damaging healthy tissue.
-  Evaluate the translational potential and safety profile of synergistic low-concentration silver, menthol irrigation in reducing readmission rates and mortality for vulnerable patient populations.

# SSI Global Clinical and Economic Burden

Despite modern surgical practice and evidence-based surgical care, SSI remains a major clinical challenge.

Up to 60% of SSIs are preventable

20%

Of all hospital-acquired infections are Surgical Site Infections

+\$3.3B

Estimated annual economic burden of SSI in the United States

+9.7 Days

Average additional hospital stay due to SSI

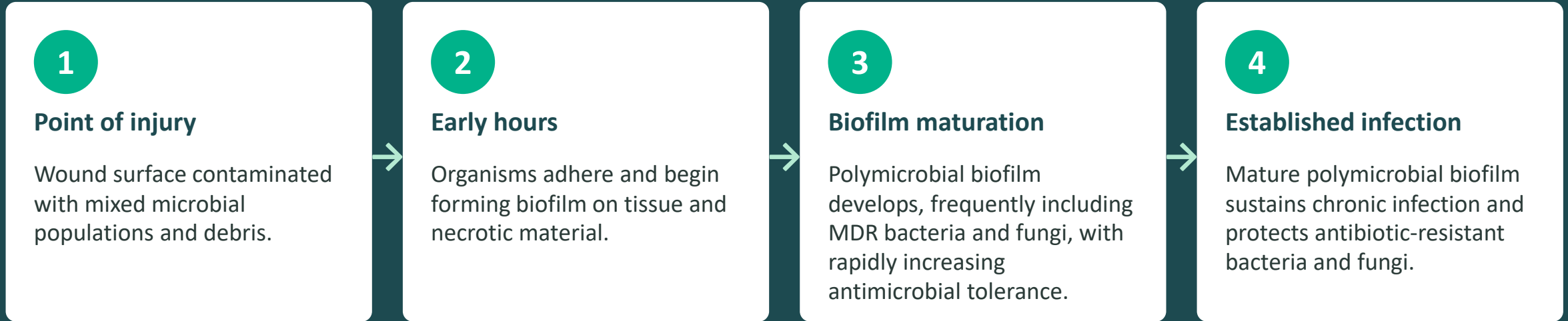
3%

Higher risk of death in patients with SSI

**Biofilm** changes the rules  
reducing the effectiveness of antibiotics and antiseptics.

# Combat Wounds: A Biological Risk Timeline

~14% combat casualty  
laparotomy SSI rates



**The “golden hour,” biologically:** the window before biofilm consolidates is when the microbial burden is most accessible. Acting early, before tolerance rises, is biologically rational.

**Minutes:**  
Residual microbial attachment

**6 - 12 hours:**  
Early biofilm formation

**24 -72 hours:**  
Mature biofilm

**Days - Weeks:**  
Potential development of a SSI

"What if the final rinse before closure could keep working for hours *after* the wound is closed?"

# A Multi-Component Synergy

## FORMULATION PHILOSOPHY

**PATENTED MULTI-MECHANISM FORMULATION**

**Synergistic combination enables low silver concentration**



**Ionic Silver (Ag<sup>+</sup>)**

Immediately available biologically active form. Acts on multiple microbial targets.

+



**Menthol**

Patented synergy with ionic silver allows significantly lower silver concentrations.





**At least 2-fold and potentially 10-fold reduction in silver concentration while maintaining antiseptic activity.\***

\*According to the patented formulation concept (EP 3 106 157 B1)

### The synergy that carries silver into the wound bed



**Low-concentration AgNO<sub>3</sub> (0.01% w/v)**

Delivers immediately available ionic silver at a tissue-compatible dose, active without damaging healthy tissue.



**Menthol**

Supports penetration into the wound bed, helping the solution reach organisms sheltered in biofilm and crevices.



**Surfactant (Tween 20)**

**Enhances the effectiveness of low-concentration silver**

- Lowers surface tension for complete wound-surface wetting and coverage.
- Improves contact between ionic silver (Ag<sup>+</sup>) and residual microorganisms across the entire wound surface.
- May potentiate the biological activity of low-concentration ionic silver**, supporting effective antimicrobial performance at a tissue-compatible silver concentration.\*

**Better Coverage = More Ag<sup>+</sup> Interaction = Enhanced activity**



**Glycerol**

Supports moisture balance and osmotic activity, helping maintain a favorable wound environment.



**pH Buffer (TRIS)**

Maintains a near-physiological pH to support formulation stability and tissue compatibility.

# Laboratory Evidence Supporting the Formulation Concept

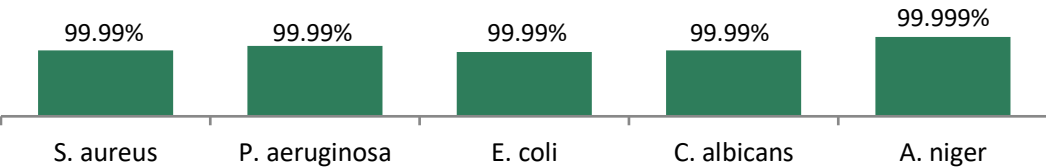
*In vitro antimicrobial and anti-biofilm performance*

## 1 1 ANTIMICROBIAL ACTIVITY

**Objective:** Evaluate efficacy against clinically relevant planktonic microorganisms. Broad-spectrum in vitro activity

| Test Organism                 | Type   | Log <sub>10</sub> Reduction |
|-------------------------------|--------|-----------------------------|
| <i>Staphylococcus aureus</i>  | Gram + | ~5                          |
| <i>Pseudomonas aeruginosa</i> | Gram – | ~5                          |
| <i>Escherichia coli</i>       | Gram – | ~5                          |
| <i>Candida albicans</i>       | Yeast  | ~5                          |
| <i>Aspergillus niger</i>      | Mold   | >5                          |

Mean Log<sub>10</sub> Reduction at 28 Days



USP <51> ANTIMICROBIAL EFFECTIVENESS TEST (28 DAYS)



**Clinical relevance:** Immediate reduction of residual microorganisms before wound closure.



Together, these independent laboratory studies evaluated two complementary biological challenges relevant to SSI prevention: planktonic microorganisms and mature polymicrobial biofilm.



## 2 2 ANTI-BIOFILM ACTIVITY

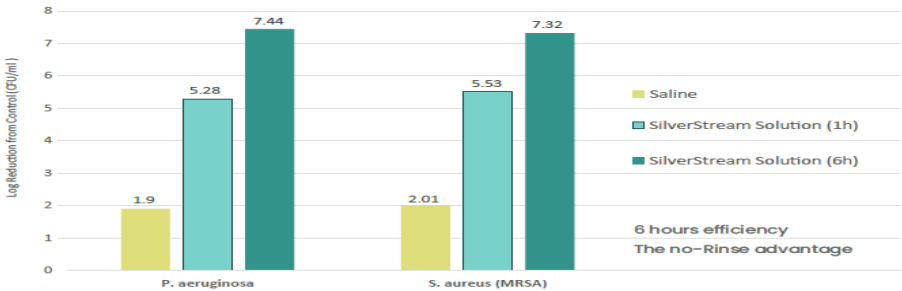
**Objective:** Determine activity against mature polymicrobial biofilm.

### CENTER FOR BIOFILM ENGINEERING

Montana State University, USA

#### MATURE DUAL-SPECIES BIOFILM MODEL

*MRSA + Pseudomonas aeruginosa*  
(6 - HOUR EXPOSURE)



>7-LOG REDUCTION  
in mature biofilm



**Clinical relevance:** Targets microorganisms protected within established biofilm.

# Laboratory Evidence Supporting the Formulation Concept

*In vitro antifungal performance*

## ANTIFUNGAL ACTIVITY

**Objective:** Evaluate activity against clinically relevant fungal pathogens.

| Study / Organism                                       | Model                          | Outcome                         |
|--------------------------------------------------------|--------------------------------|---------------------------------|
| <i>T. rubrum</i> (clinical isolate)                    | Time-kill bioassay             | Significant fungicidal activity |
| <i>T. rubrum</i> (NCPF 118)                            | Comparative fungicidal assay   | Significant fungicidal activity |
| <i>M. canis</i> (clinical isolate)                     | Comparative fungicidal assay   | Significant fungicidal activity |
| Sequential Silver-Menthol – PHMB + surfactant workflow | 24-day repeated exposure model | Sustained fungicidal effect     |



**Clinical relevance:** Evaluates fungal pathogens that may contribute to contaminated wounds.



This independent laboratory work evaluated antifungal activity against clinically relevant fungal pathogens that may contribute to contaminated wounds.



# Clinical and Real-World Evidence

Electric burns + **Pseudomonas infection** + debris and secretions

2nd degree burns + **Staphylococcus aureus**

Baseline WEEK 0

After Synergistic Silver Solution WEEK 2

After Synergistic Silver Solution WEEK 3

After 3 weeks and before skin grafting

Baseline WEEK 0

After Synergistic Silver Solution WEEK 0.75 (DAY 4)

After Synergistic Silver Solution WEEK 1.75 (DAY 12)

NECROTIZING SOFT TISSUE INFECTION AND MULTIPLE BOWEL PERFORATIONS AFTER LIPOSUCTION PROCEDURE

Discharge after 5 month of hospitalization:  
3 month in ICU  
2 month in General Surgery unit

Base Line

AFTER SILVERSTREAM BEFORE SKIN GRAFT

HEALING PROCESS AFTER SKIN GRAFT

>250 ml of SilverStream was used per day, 3 weeks as a wound bed preparation for skin graft. Infection reduction was observed with good growth of granulation tissues covering area even before skin grafting. 13 skin graft surgeries performed successfully during the treatment. Combined with alginogel enzyme for bed preparation before skin graft in a 5-month ICU liposuction-necrosis case

POST-SURGERY SSI | When every antibiotic line had failed

Implant-associated MDR bacterial infection resolved after multidrug resistance

40-yr male • bilateral acetabular fracture • post-op SSI

BEFORE SILVERSTREAM: RESISTANT ON EVERY FRONT

- ✗ Wound wash + IV antibiotics — *unresponsive*
- ✗ Cefoperazone-sulbactam — *culture showed resistance*
- ✗ Chloramphenicol — *reduced pus, did not stop it*
- ✗ Meropenem — *temporary relief only*

Pathogens: Klebsiella + anaerobes (MDR)

IMAGING : Pre and Post Op

Figure 1: Pre-op X-ray — bilateral quadrilateral plate fracture

Figure 2: Pre-op CT — bilateral quadrilateral plate fracture

Figure 3: Post-op X-ray — bilateral buttress-plate fixation

IMAGING : Treatment

Figure 4: Silverstream and VAC Therapy.

Figure 5: Follow up : 6 months Follow-up at 3 months and 6 months revealed no signs of infection

✓ The bottom line: An implant-associated infection that resisted four escalating antibiotic regimens - up to meropenem - was brought under control with SilverStream using in VAC, without removing the fixation.

~90% Wounds with active biofilm on arrival

100% Amputation prevented in documented complex cases

100% Infection resolution across treated wounds reported

0 Adverse events or toxic reactions reported

A Three-Step Multimodal Biofilm-Focused Protocol in Complex Acute and Chronic Wounds

| Case #1 | Case #2 | Case #3 |
|---------|---------|---------|
|         |         |         |
|         |         |         |
|         |         |         |
|         |         |         |

Nov 3, 2023 Initial Stage

Nov 14, 2023 Early Healing

Nov 20, 2023 Reconstruction

Dec 26, 2023 Maturation

Chausa Weitman C, Greenberg I. A Three-Step Multimodal Biofilm-Focused Protocol in Complex Acute and Chronic Wounds: Clinical Outcomes from ICU Real-World Patients. Journal of Multidisciplinary Clinical and Nursing Sciences. 2025. DOI: 10.61440/JMCNS.2025.v3.100

# A Novel Strategy for SSI Prevention

## TODAY

 **ANTIBIOTICS** prophylaxis  
Prevent and treat bacterial infection

 **METICULOUS**  
Surgical Technique

 **ANTISEPTICS**  
Rapid reduction of microbial burden

 **IRRIGATION**  
Flush contaminants and debris

Each plays a critical role, but each addresses a different aspect of SSI prevention.



CLINICAL  
EXPERIENCE



SCIENTIFIC  
UNDERSTANDING



INTEGRATED  
STRATEGY

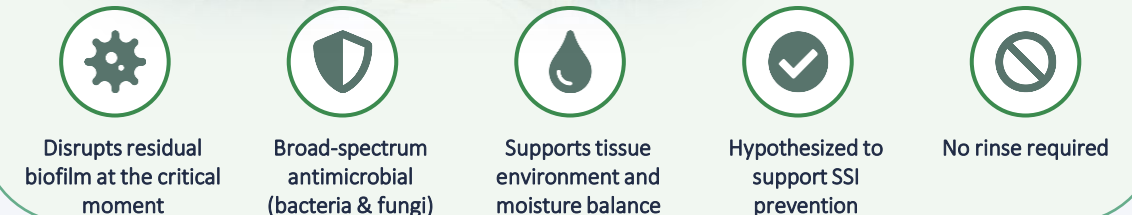


Proposed investigational adjunct for evaluation in prospective SSI studies:  
**ADD SILVER-MENTHOL SOLUTION JUST BEFORE CLOSURE**

### SURGICAL PROTOCOL (EXAMPLE)



### WHY ADD SILVER-MENTHOL SOLUTION JUST BEFORE CLOSURE?



The future of SSI prevention is not replacing today's standards –  
it is integrating complementary mechanisms to prepare the wound before surgical closure.

# Safety & Biocompatibility Profile

## ISO 10993 biocompatibility and GLP porcine wound-healing testing

| Evaluation                   | Standard / Study                                             | Testing Laboratory              | Result                                      |
|------------------------------|--------------------------------------------------------------|---------------------------------|---------------------------------------------|
| Cytotoxicity                 | ISO 10993-5                                                  | NAMSA                           | Non-cytotoxic                               |
| Skin Sensitization           | ISO 10993-10                                                 | NAMSA                           | Non-sensitizing                             |
| Intracutaneous Irritation    | ISO 10993-10                                                 | NAMSA                           | Non-irritant                                |
| Acute Systemic Toxicity      | ISO 10993-11                                                 | NAMSA                           | Non-toxic                                   |
| Local Tissue Response        | ISO 10993-6 GLP Porcine Full-Thickness Wound Model (31 days) | Envigo CRS (GLP) Histopathology | Minimal or no tissue reaction               |
| Wound Healing Performance    | GLP Porcine Full-Thickness Wound Model                       | Envigo CRS Israel (GLP)         | No negative impact on natural wound healing |
| Repeated Topical Application | 31-day repeated application                                  | Envigo CRS Israel (GLP)         | No treatment-related adverse effects        |

# Proposed Three-Step Biofilm-Focused SSI Prevention Strategy

## What is established

- Broad-spectrum antimicrobial activity in vitro
- Biofilm **>7-LOG** log-reduction (6-HOUR EXPOSURE)
- Tissue compatibility (ISO 10993-5)
- Compatibility with standard surgical irrigants, enabling a three-step adjunct SSI prevention protocol (3-Step protocol)
- Broad clinical experience across wound management

Do not change your protocol today.  
Add silver-menthol solution just before closure

### STEP 1

#### Mechanical Irrigation

Saline irrigation to remove debris and reduce contamination

### STEP 2

#### Antiseptic Irrigation

Diluted povidone-iodine (PVP-I), HOCl, or the surgeon's preferred antiseptic protocol.

### STEP 3

#### Final Silver-Menthol Irrigation

#### Apply silver-menthol solution

immediately before wound closure.  
Leave in place. Proceed to closure.

## Key Clinical Concept

SSI prevention is multimodal. Each step contributes a distinct mechanism, creating a complementary strategy rather than replacing existing practice.

# From Treating Infection to Understanding Prevention

## RESEARCH QUESTION:

Does a low-concentration silver nitrate formulation, combined with its complementary components and applied as a leave-on, no-rinse irrigation before surgical closure, reduce residual microbial burden and, in turn, surgical site infection and its downstream outcomes?

## PROPOSED NEXT STEP:

We welcome the opportunity to follow up with the MHSRS research community to design and conduct a prospective, comparator-controlled clinical trial that tests this hypothesis in combat-related and high-risk surgical care.

The resulting clinical evidence would provide the foundation for future regulatory evaluation, including submission to the U.S. FDA for this intended surgical application.