Preclinical Evaluation of a Spray-On Nanopolymer Hydrogel for Full-Thickness Burn Management in a Porcine Prolonged Field Care Model

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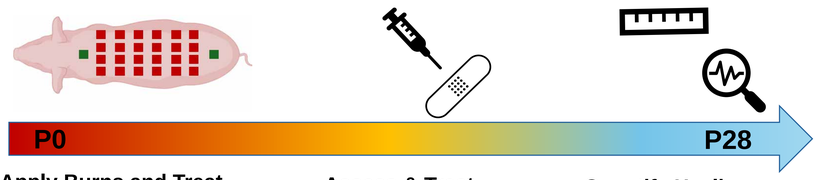
Background

Combat-related polytraumatic injuries, particularly the combination of burns and blast trauma, are highly susceptible to infection, making them a leading cause of casualty morbidity, mortality, and amputation in modern prolonged field care environments. With anticipated tactical evacuation timelines routinely exceeding 72 hours, the traditional "one wound, one dressing" logistical paradigm is unsustainable in austere, resource constrained operational settings. To bridge this capability gap, Field Shield Wound Dressing (FSWD) was developed as a lightweight, spray applied antimicrobial nanopolymer hydrogel containing lidocaine, engineered to establish a semi occlusive protective barrier that simultaneously delivers continuous tissue moisture and active localized analgesia. This study evaluated the feasibility of Field Shield Wound Dressing to support the healing of full thickness burns over an extreme 14 day delayed surgical intervention protocol simulating a worst-case prolonged field care scenario and compared its performance against three silver-based controls: two silver hydrosol hydrogels (KeriCure Advanced Shield Hydrogel and ASAP Hydrogel) and a standard of care silver nylon dressing (Silverlon).

Experimental Design



Apply Burns and Treat

24 wounds (5x5cm), ~15% total body area (full thickness)

Treat with FSWD, Advanced Shield® Hydrogel, ASAP Silver Hydrogel or Silverlon®

Assess & Treat

Every 3 – 4 days:

- Assess wound severity
- Swab for microbes
- Image wounds
- Reapply treatment
- POD 14 assessment for surgical debridement

Quantify Healing

- Determine wound assessment scores
- Calculate percent wound closure
- Identify microbes present

Assessment Scores

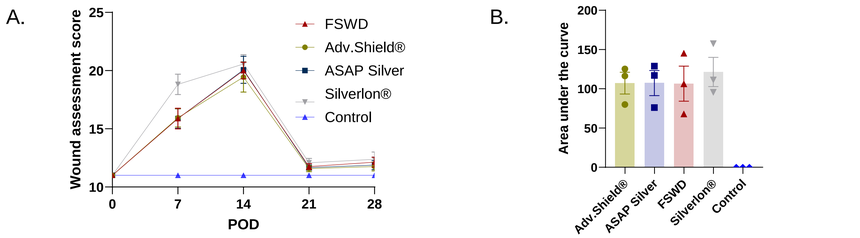


Figure 1. Wound Assessment Scores by Treatment. A) Graph representing wound assessment scores for each treatment over 28 days. Wound assessment scores are sum of values assigned in 11 categories. Each category is scored on a scale from 1 (none/normal) – 5 (high/severe) in the following: depth, edges, necrotic tissue type and amount, exudate type and amount, skin color surrounding wound, peripheral tissue edema and induration, granulation tissue and epithelialization. Mean ± SEM, n=16/tx. **B)** Area under the curve measurements for each animal corresponding to panel A.

Wound Images

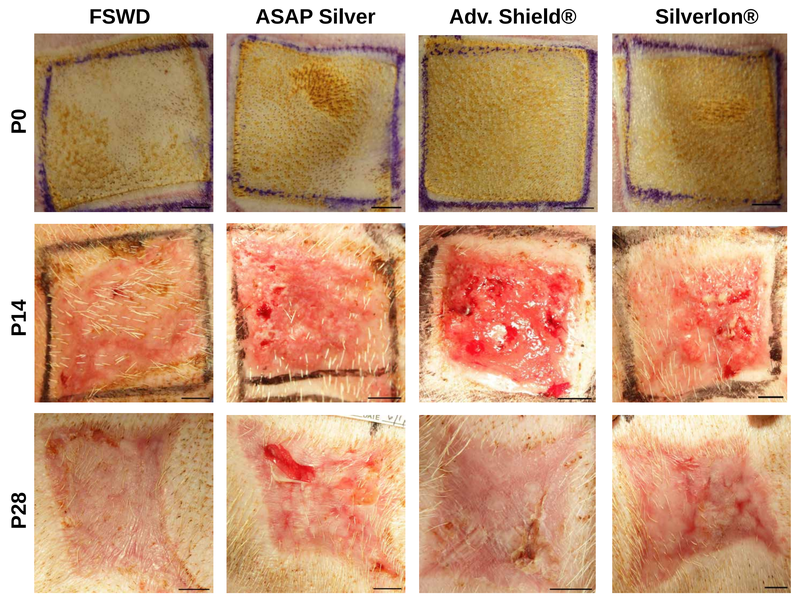


Figure 2. Wound Images. Representative wound images for each treatment taken at 0, 14, and 28 days post-op. Images taken with a Cannon EOS 5D Mark II camera. Scale bar = 1 cm.

Histology Images

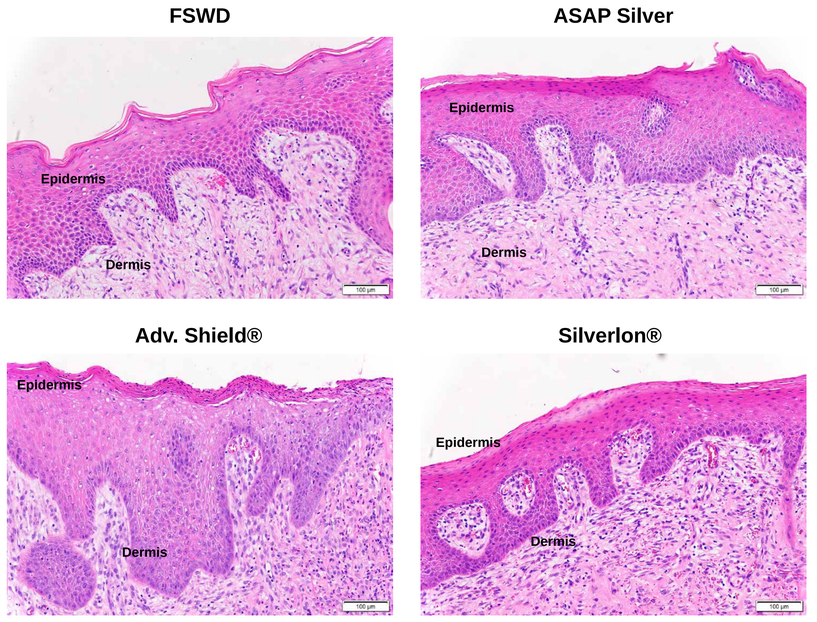


Figure 3. Wound Histology. Representative wound histology images for each treatment taken at 28 days post-op showing similar wound healing with all treatments. Tissue sections were stained with hematoxylin and eosin. Images were taken with Olympus BX63 light microscope at 20x magnification. Scale bar = 100µM.

Percent Wound Closure

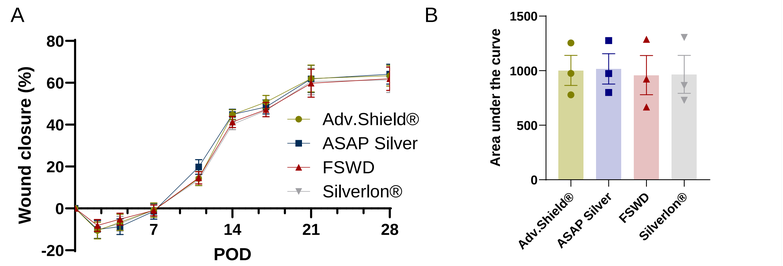


Figure 4. Percent Wound Area Closure by Treatment. A) Graph representing wound area closure over time, normalized to the closure area of the burn at P0 as 0%. Mean ± SEM, n=16/tx. **B)** Area under the curve measurements for each animal corresponding to panel A.

Debridement

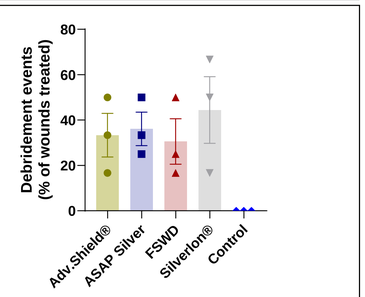


Figure 5. Number of Debridement Events in Each Animal by Treatment. Debridement events are represented as percent of total number of wounds treated during experiment. n=3.

Microbial Diversity

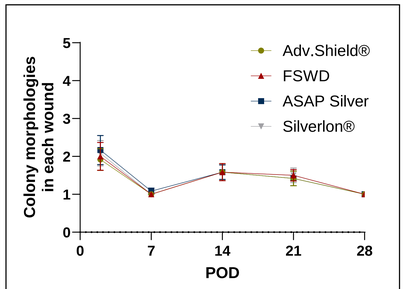


Figure 6. Number of Distinct Colony Morphologies per Swab. A) Each wound was swabbed in the established POD. Mean ± SEM. n=12/tx.

Conclusions

- Spray-applied antimicrobial nanopolymer dressings show significant promise as a lightweight, logistically favorable temporizing treatment for TBSA full-thickness burns in PFC scenarios.
- FSWD supported the natural wound-healing cascade, enabling progressive wound closure by Day 28 without excess debridement or increased risk of infection.
- These findings suggest that nanopolymer hydrogels can serve as a crucial intervention when definitive surgical care and evacuation are significantly delayed.
- Although microbial diversity was found in the wounds, no significant immune response was seen in the blood via CBC panel (data not shown) confirming that no significant systemic infection occurred.

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Institutional Animal Care and Use Committee: The study protocol was approved by the Naval Medical Research Command Institutional Animal Care and Use Committee, in compliance with federal regulations.