



# Frontline Seal-48

Multifunctional Combat Wound Dressing

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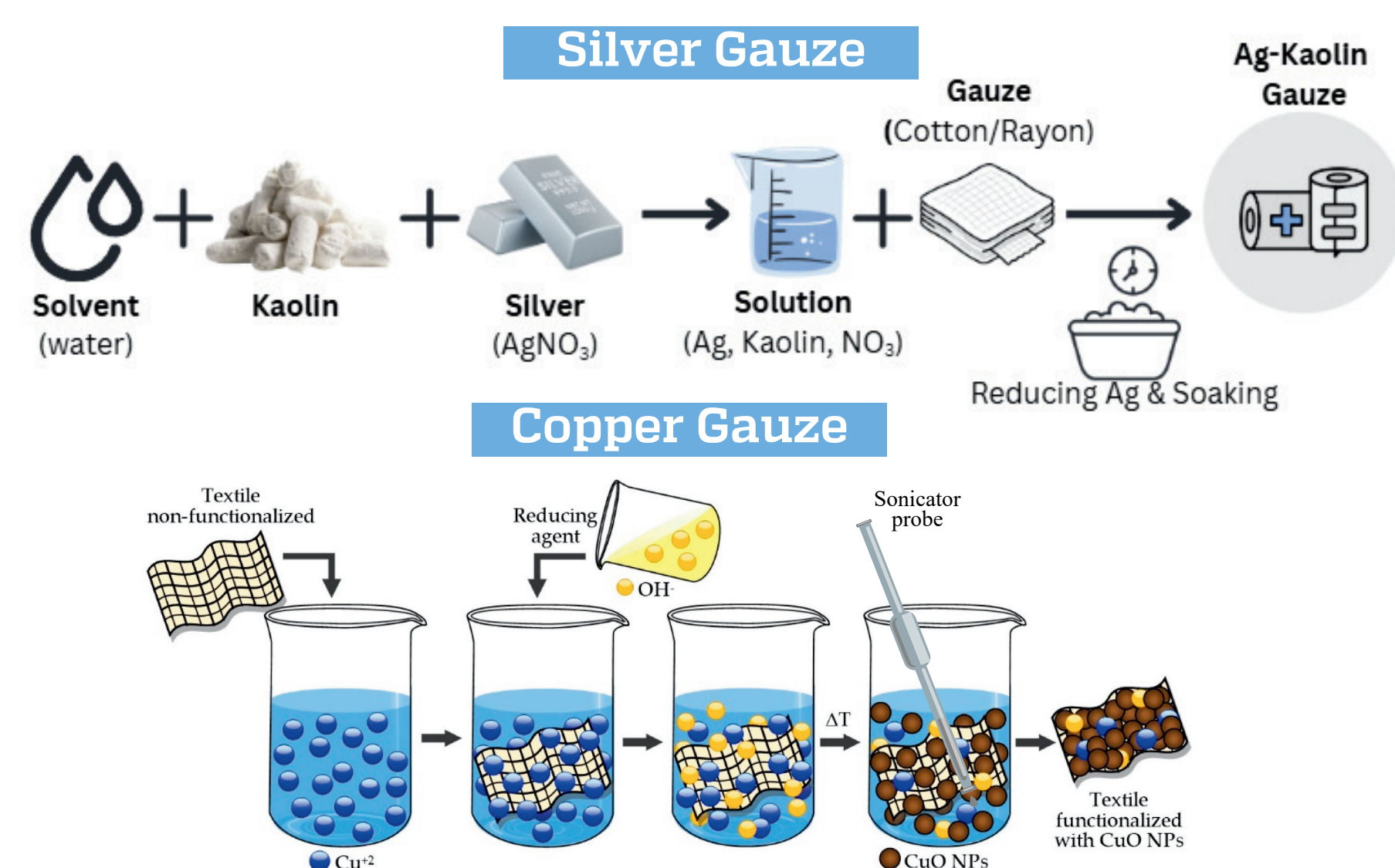
## Problem

- Modern warfare (contested airspace, fewer safe havens) → **evacuation delays from hours to days**
- Prolonged field care **increases exposure** to contaminated wounds
- Rising **antimicrobial resistance** → higher risk of infection

## Solution

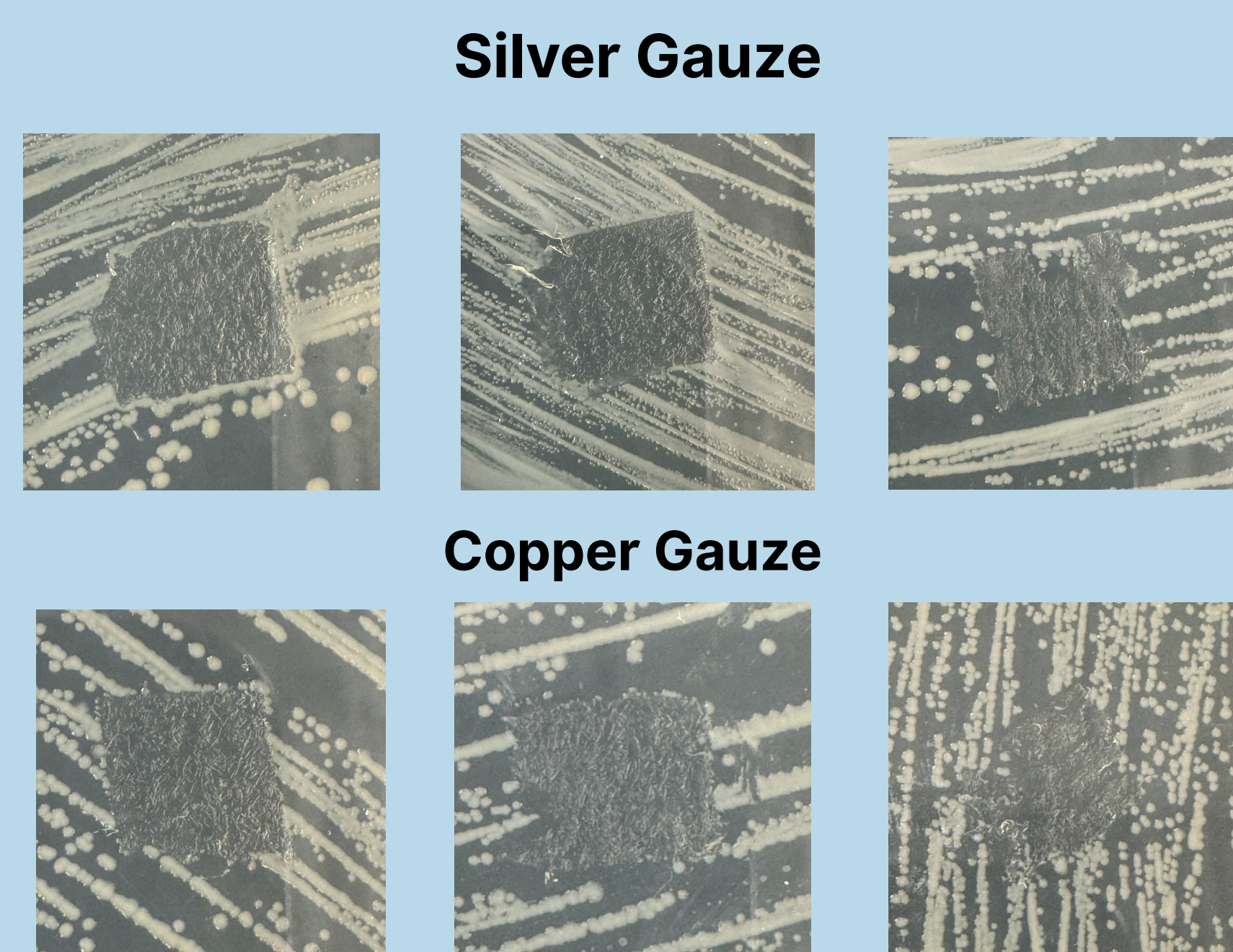


## Gauze Fabrication



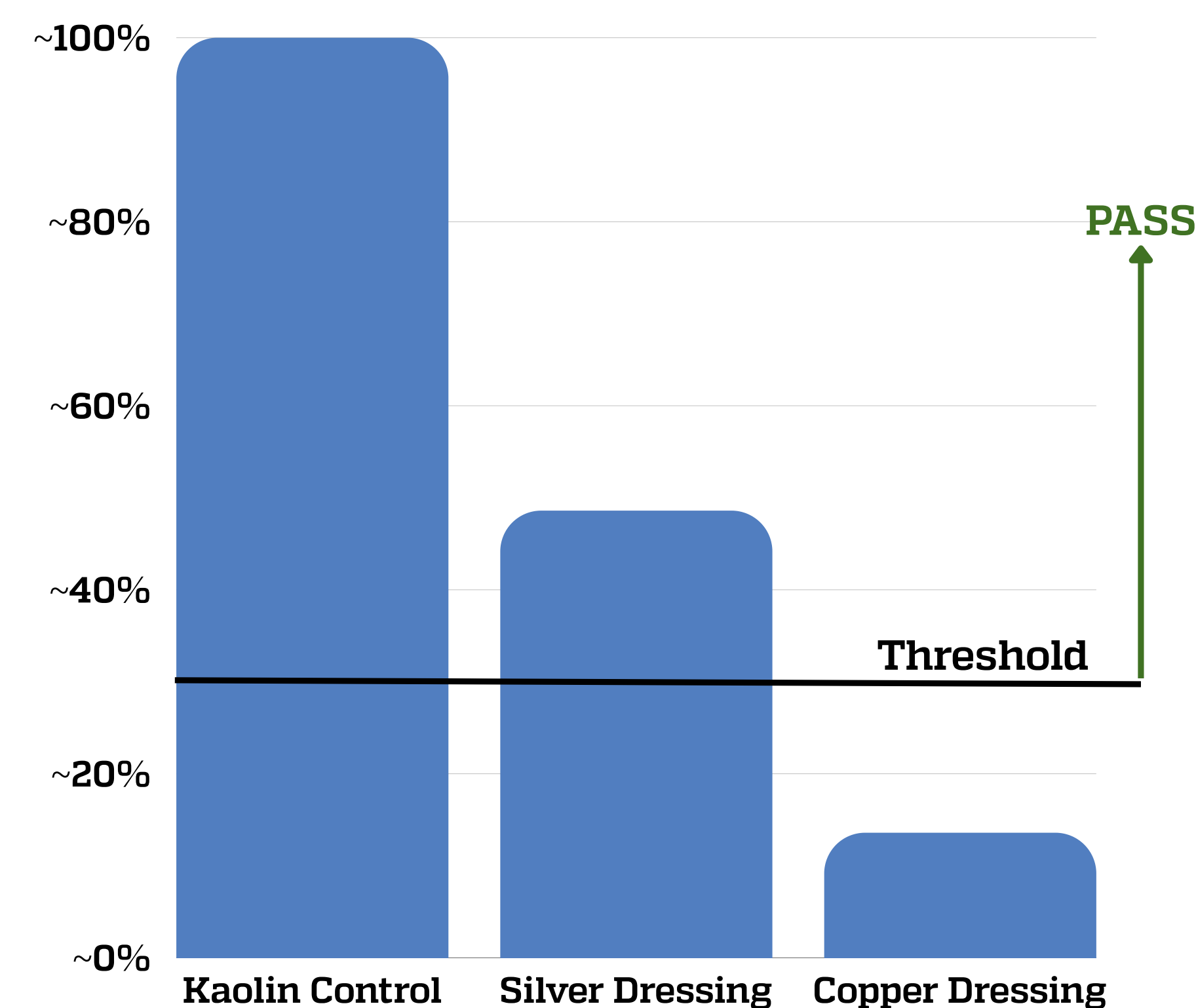
## Results

### Zone of Inhibition



- **Zone of Inhibition Test:** Measures antimicrobial effectiveness by the clear area around the sample, larger zone = stronger bacterial inhibition.
- Both silver and copper gauze show visible zones of inhibition
- Differences in size and uniformity are qualitative and not conclusive
- Conclusion: **No definitive comparison** can be made from these images alone

### Kaolin Retention Comparison



- **Kaolin Retention Test:** Measures particle loss after fluid exposure, lower = better retention.
- **Kaolin Control:** Low, consistent shedding (~0.96 mg/cm<sup>2</sup>).
- **Silver:** ~2× higher shedding (~48.6% retention), within acceptable limit (≤3× control).
- **Copper:** ~7× higher shedding (~13.6% retention), exceeds limit.
- **Conclusion:** Silver shows acceptable retention. Copper requires optimization.

### 2-Compartment PKPD Model of Metal Nanoparticle Gauze

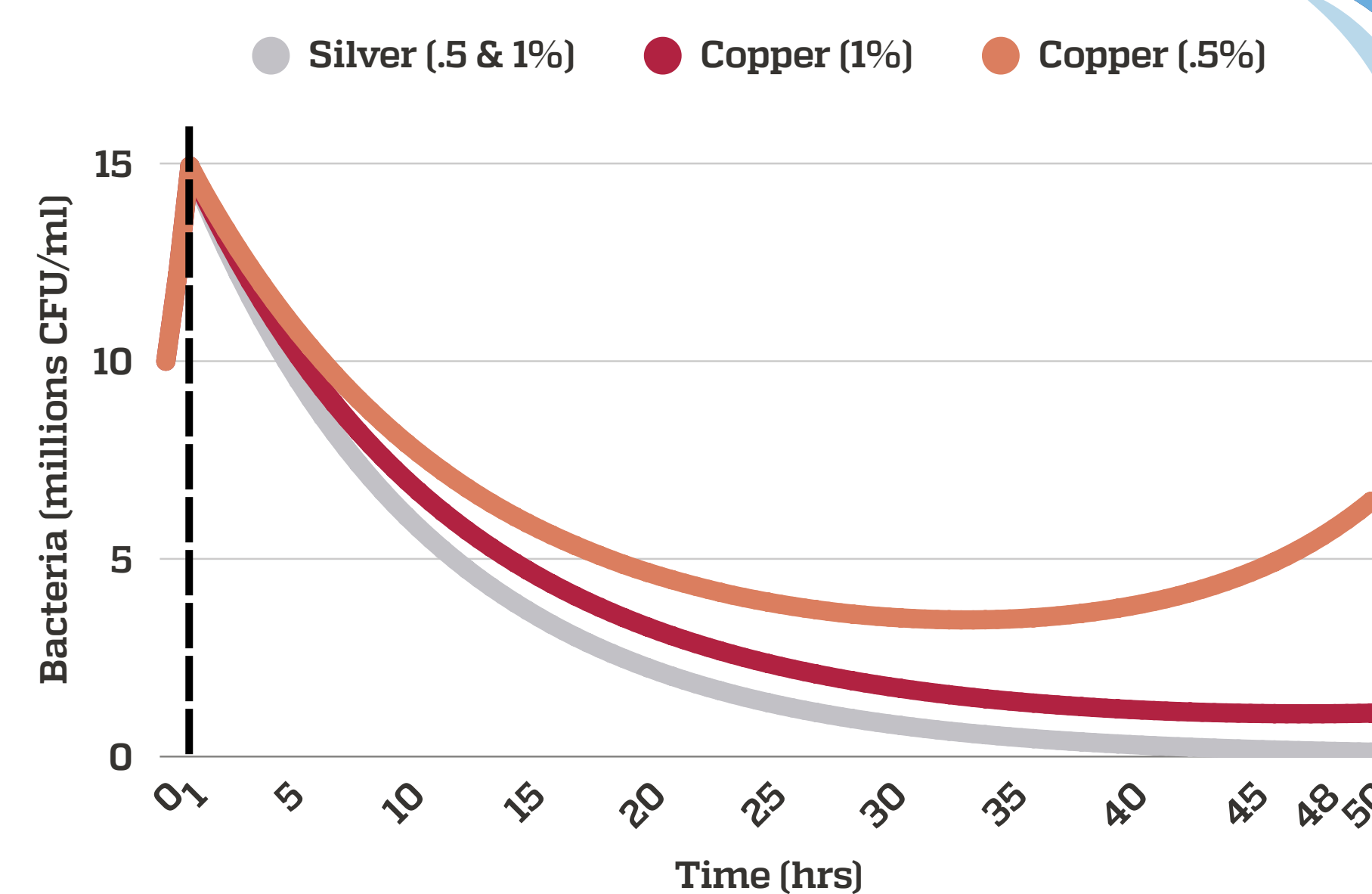
Pharmacokinetic & Pharmacodynamic modeling provides a nuanced understanding of antimicrobial mechanisms and optimal loading.

$$\frac{d[MNP]}{dt} = IN - OUT + GEN - CON$$

$$\frac{d[MNP_w]}{dt} = k_{G \rightarrow W}[MNP_G] \frac{V_G}{V_W} - k_{W \rightarrow G}[MNP_W] - k_{kill}[MNP_W][Bac] - k_{fwd}[MNP_W][Cl_W]$$

- Further incorporates contact-based killing, ROS generation, and deactivation by wound fluid constituents.
- Gauze payload occurs at 1 hour. Blood diffuses into the wound and MNPs react into activated forms, leeching to the wound site.
- **Key Takeaways:** Both formulations show significant inhibition of bacterial growth over 48 hours. CuO efficacy is more sensitive to initial loading than Ag, likely due to higher reliance on ROS-mediated killing.

### Wound Bacterial Burden



## Business Case

- **Strategic Partnerships:** Leveraging JHubMed and NATO to streamline regulatory navigation and secure direct military procurement channels.
- **Strong Unit Economics:** Manufacturing cost of \$5-\$8 against a \$35 bulk contract price, yielding a ~80% gross margin.
- **Scalable Market Segments:** Initial military focus with expansion into disaster relief, remote medicine, and the outdoor/adventure sectors.

## Conclusions

- **Zone of Inhibition:** Both silver and copper demonstrate antimicrobial activity; no definitive comparison can be made from images alone
- **Kaolin Retention:** Silver meets retention criteria, while copper exceeds shedding limits and requires optimization
- **Future Work:**
  - Evaluate cytotoxicity and biocompatibility
  - Test hemostasis in wound fluid and blood
  - Expand antimicrobial testing (external labs) to more gram-negative bacteria (AATCC 100 test)
  - Further testing for antimicrobial activity

## Acknowledgements

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## Supporting Materials

Scan to access our complete presentation, project video and references.

