PROTECTION - SCIENCE AND TECHNOLOGY ADVANCES FOR CHEMICAL AND BIOLOGICAL PROTECTION

Protecting The Suit That Protects The Soldier

Erin Anderson US Army DEVCOM Soldier Center **Molly Richards** US Army DEVCOM Soldier Center **Robert Stote** US Army DEVCOM Soldier Center **Victoria Williams** US Army DEVCOM Soldier Center **LeNaiya Kydd** US Army DEVCOM Soldier Center **Isabella Hodges** US Army DEVCOM Soldier Center **Julia Luehr** US Army DEVCOM Soldier Center

Historically, Chemical/Biological (CB) garment designs are heavier and have a greater thermal burden than duty uniforms. The added burden is necessary for CB garments to withstand repeated launderings, which can degrade both the textile and protective materials. Reduced launderings would allow for lighter suits, and present new opportunities for protective materials to be used that otherwise could not withstand laundering.

To reduce laundering requirements, suit hygiene must be maintained with repeated wear. The addition of an antimicrobial to the under or inner layer in a CB garment could potentially control growth of microbes coming from the wearer's skin. Accurately predicting this is difficult, as there are a number of challenges with correlating antimicrobial testing in the lab to results from the field. This is especially true with repeated unlaundered wear not typically assessed using current laboratory standards. There are additional considerations on how antimicrobials could impact CB protection or affect the wearer's natural microbiome, particularly with antimicrobial technologies that leach from the fabric. Challenges understanding how antimicrobial efficacy predicts suit hygiene in the field have several contributing factors. Worn suits create a more complex environment than is assessed in the lab. Unlaundered, worn suits contained sweat, sebum, and dead skin cells from the wearer. Additionally, environmental microbes not considered in lab testing made up a large portion of those recovered and identified. A single antimicrobial technology may not be sufficient to target all organisms that contribute to hygiene and odor issues.

To address these challenges, we evaluated a variety of antimicrobial fabrics in the lab for antimicrobial efficacy against gram positive and negative organisms, leaching off the textile, and potential for integration into a CB garment. Lab performance was compared to worn suits from the field which contained a zinc-based antimicrobial. Metal-based antimicrobials, such as zinc and copper, had the highest potential for integration with CB fabrics and the least amount of leaching from the textile in lab testing. Worn suits had microbial growth and odor, even with an antimicrobial present. Antimicrobial efficacy testing, DNA extraction and 16S sequencing, and an odor sensory panel were used to evaluate worn, unworn, laundered, antimicrobial, and non-antimicrobial CB garments and better understand if an antimicrobial can address the odor aspect of suit hygiene.

Lab evaluations alone are not fully able to predict hygiene of unlaundered CB suits. Future work must focus on how lab tests can better predict suit hygiene. A better understanding of microbial log-kill and suit hygiene is needed. Determining if specific suit microbes should be targeted to improve suit hygiene by reducing odor, preventing pathogen growth, or limiting overall microbe growth will help develop more effective antimicrobial technologies. Anti-fouling surfaces, which were not considered in this work, may be necessary to prevent buildup of sweat, sebum, and skin cells in unlaundered suits and could drastically change field results. Further method development is needed to address reduced laundering needs that could provide lighter CB suits to the Soldier.