PROTECTION - SCIENCE AND TECHNOLOGY ADVANCES FOR CHEMICAL AND BIOLOGICAL PROTECTION

Deploying Far-UVC For Biodefense: Opportunities And Research Priorities

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Germicidal Ultraviolet Radiation (GUV) has potential for improving existing DoD biodefense capabilities to defend against next-generation biological threats, especially those threats that are engineered and transmissible. GUV is already used for broad-spectrum disinfection of unoccupied spaces, including surgical theaters, biosafety cabinets, and air ducts. Far-UVC is a form of GUV with intrinsic properties that make it safer for use in occupied settings, with comparable efficacy to conventional GUV. Our research covers the current state and future potential of far-UVC, identifying the gaps between the current state of knowledge and the research needed for warfighter use.

Our analysis suggests that far-UVC fixtures can provide protection against biological attacks that complement personal protective equipment (PPE). However, commercial off-the-shelf (COTS) designs are unlikely to be well suited for this purpose. We propose purpose-built fixtures that have different characteristics to COTS designs, engineered to work in tandem with PPE to protect against especially high concentrations of pathogens or UV resistant microorganisms. Using higher UV power, different GUV wavelengths or multiple wavelengths in combination requires research into the absorption spectra and degradation of materials in equipment that would be exposed during use, especially materials used in PPE against biological attacks.

Integrating the use of far-UVC with PPE not only provides a dual-layer of defense that could enhance overall protection, but also increases the amount of UV power that can be safely used in an occupied space by protecting skin and eyes from direct exposure. By using far-UVC lamps in combination with PPE, GUV power of 10 to 100 times higher could potentially be used in environments where high concentrations of pathogens are present, dramatically reducing the risk of exposure to biological weapons during critical operations. These high power levels, while ideal for countering biological attacks, are overlooked in current studies where the mandatory use of PPE is not viable. Dimmable lamps could provide a base layer of protection before an attack is detected, with power output increased once PPE is in use.

To inform our work, we undertook comprehensive literature reviews across multiple fields including disinfection efficacy, photobiological safety, materials interactions, and atmospheric chemistry, as well as semi-structured interviews with over 100 industry and academic experts to form the knowledge base for our recommendations. The semi-structured interviews include both open-ended questions, as well as specific questions previously identified from literature reviews and other interviews. Additionally, to quantify our assessment and place it in the context of existing literature, we have developed a parametric model based on the Wells-Riley model of airborne infection risk. We identify key research priorities and technology attributes needed to realize the potential of far-UVC disinfection in military settings, focusing on how future research and development could impact the JSTO mission and the Joint Force.

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