PROTECTION - SCIENCE AND TECHNOLOGY ADVANCES FOR CHEMICAL AND BIOLOGICAL PROTECTION

Exploring The Skin Decontamination Potential Of A Novel Zirconium Hydroxide Prototype Against Chemical Warfare Agents With Comparative Analysis To RSDL

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Chemical warfare agents (CWAs) continue to be employed by states or terrorist organizations, emphasizing the ongoing necessity to devise efficient countermeasures. Given that numerous CWAs cause harm through skin contact, rapid and effective decontamination of the skin is imperative. Currently, the US military employs the use of Reactive Skin Decontamination Lotion (RSDL®) as a countermeasure for dermal exposure to CWAs. Despite the effectiveness of RSDL as a skin decontaminant, there are reported limitations associated with the product including issues with shelf-life and stability. Furthermore, the oily residue left on the skin following its use has been highlighted as a limitation that could impact a warfighter's ability to effectively continue a mission. For these reasons, it is important to develop an effective dry absorbent product with neutralising properties against CWAs, while ensuring that it is easy to manufacture, stable and cost-effective.

Zirconium hydroxide has been identified as being a highly absorbent material with rapid neutralisation capabilities against VX, soman and sulphur mustard[1]. Here, we evaluate the efficacy of Reactive Skin Decontamination Lotion (RSDL®) and a zirconium hydroxide (Zr(OH)4) containing prototype mitt against radiolabelled CWAs. The most effective application methods were simultaneously assessed by performing decontamination using either a blotting, circular or a combined blotting & circular motion using a robotic arm. The study was performed using a modified skin diffusion cell[2] on excised porcine skin. A 20 µL droplet of CWA was applied to the skin surface. After 5 minutes, decontamination was performed using a robotic system (Igus Robolink® RL-DP), ensuring that decontamination was performed consistently across all products and replicates. Receptor fluid and air samples were collected throughout the experiments which were terminated 15 minutes post-dose. Full mass balance distributions were obtained by radiometric analysis. The bioavailable dose (agent remaining on this skin surface, within the skin or penetrated through the skin) and the amounts off-gassed were utilised as endpoints to ascertain the efficacy of the decontaminants and to identify the most effective decontamination application method. Furthermore, the samples were analysed via traditional analytical methods to determine the neutralisation capacity of these products and to link them with previous studies.

Future studies will assess the most suitable application method for these products on excised human skin. The ultimate output of this research is to progress the identification of an effective personal decontamination product to be fielded by the warfighter.

1. Bandosz, T.J., et al., Reactions of VX, GD, and HD with Zr(OH) 4 : Near Instantaneous Decontamination of VX. The Journal of Physical Chemistry C, 2012. 116(21): p. 11606-11614. 2. Matar, H., et al., Design and Characterisation of a Novel in Vitro Skin Diffusion Cell System for Assessing Mass Casualty Decontamination Systems. Toxicology in Vitro, 2014. 28(4): p. 492-501.

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