DEVELOPMENT AND VALIDATION OF A NOVEL DETERGENT FORMULATION FOR DERMAL DECONTAMINATION: FROM PHORATE SCREENING TO VX EFFICACY TESTING.

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INTRODUCTION

Organophosphorus nerve agents, such as VX, pose an extreme risk due to their high dermal toxicity, environmental persistence, and rapid systemic absorption. Timely and effective decontamination is crucial for reducing exposure and minimizing health effects.

This study outlines a two-phase approach to develop and validate a new surfactant-based decontamination solution, beginning with simulant testing using phorate and progressing to efficacy trials with real VX. .

MATERIAL AND METHODS

Experiments followed OECD 428 guidelines using static skin diffusion cells with porcine skin and ^{14}C-labelled phorate (Chilcott et al., 2019; Matar et al., 2022). Four conditions were tested: untreated control, water-only, and surfactant decontamination with Formulation 1 or 2 (Phase one), followed by active drying with a microfibre cloth (ORCHIDS protocol). The radioactivity in each sample was quantified using a Perkin Elmer Tri-Carb liquid scintillation counter.

Phase two involved testing an optimized formulation (Formula), informed by the results of Phase one, against ^{14}C-labelled VX on full-thickness human abdominal skin.

RESULTS AND DISCUSSION

- ✓ In the simulant phase, both detergents significantly reduced phorate absorption compared to water or no treatment, with Formula 2 performing best by limiting wash-in effects (Fig 1).
- ✓ Subsequent VX testing showed Formula 3 significantly reduced residual agent on the skin surface compared to water alone, indicating effective decontamination under realistic exposure conditions (Fig 2).

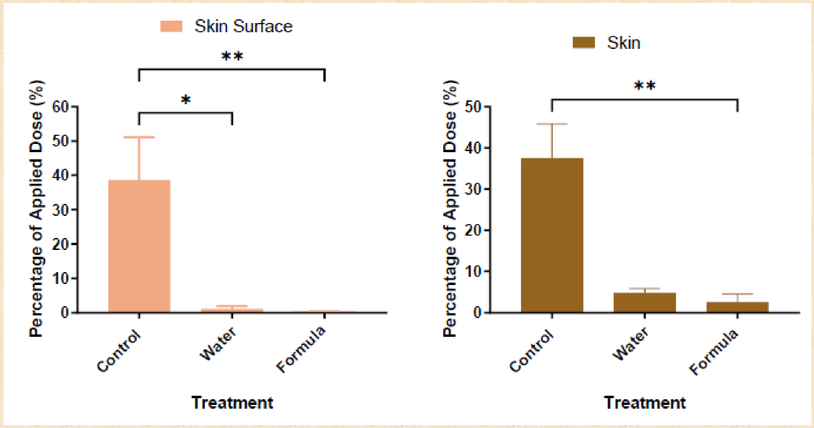

Fig 2. Dose distribution of applied 14C-VX in individual compartments. A 10 µL droplet of 14C-VX was applied to the skin surface. Decontamination was conducted at 60 minutes post exposure following technical decontamination using either water or formula 1 (flow rate of 0.6 mL min^{-1} cm^{-2}). All points are mean ± standard deviation of n=6 diffusion cells. Asterisks indicate a statistical significance when compared to the control (* $p \leq 0.05$ and ** $p \leq 0.01$).

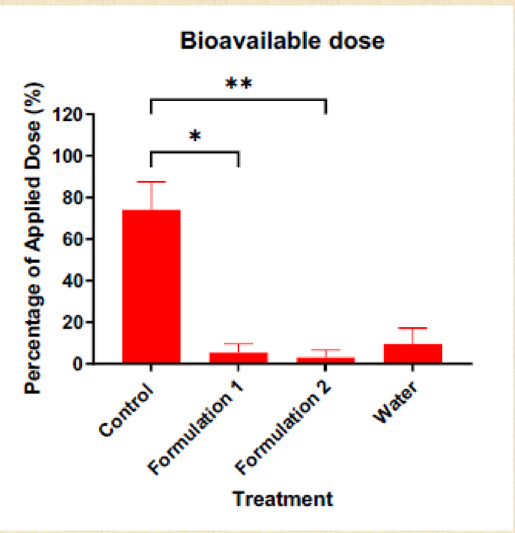

Fig 1. Bioavailable dose consisting of receptor fluid, skin surface and skin. All points are mean ± standard deviation of n=6 diffusion cells. Asterisks indicate a statistical significance when compared to the control (* $p \leq 0.05$ and ** $p \leq 0.01$).

CONCLUSIONS

This two-stage research strategy demonstrates that simulant screening is a valuable tool for optimizing decontamination solutions. The final detergent formulation provides an effective countermeasure for dermal exposure to VX, with potential applications in defense and civilian emergency response..

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