THREAT AGENT DEFEAT MODELING AND TESTING USING WMD SIMULANTS

Model Predictions of Mes Skin Exposure Informed by the Variability of Metabolite Urinary Excretion in Controlled Human Exposures

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All military and first responder protective ensembles must be tested prior to use in the field. Due to the toxicity of chemical warfare agents, simulant compounds with similar physicochemical properties are used in their place for evaluation of these ensembles. Human exposure assessments of military protective clothing against vapor intrusion commonly use methyl salicylate (MeS) as a simulant for sulfur mustard. Currently, the penetration through the clothing is measured by passive adsorbent samplers placed on the participant's skin. These passive adsorbent samplers are not representative of the amount of MeS that is absorbed through the skin after penetrating through the clothing. A model that relates MeS skin absorption to metabolites in biological samples could provide insight into the total skin exposure by vapor intrusion. A dynamic mass-transfer model was developed to predict MeS skin absorption and excretion in the urine, when employing a controlled human forearm skin exposure. This is a multi-phase model that includes skin absorption from a dosed vehicle and absorption that continues to occur after the vehicle is removed. This model can be used to fit human subject exposure data and to determine subject specific skin permeability and toxicokinetic factors. By evaluating many controlled exposure experiments, the model will generate averages and distributions of exposure parameters across the population. The model can then be used to estimate total MeS skin exposure from the urine concentrations of those exposed to MeS in field exercises, and the uncertainty associated with those estimates. This can further improve the evaluation of protective clothing efficacy in field-scale testing, by capturing a more accurate exposure dose. Ultimately, this research will contribute to the improvement in protection of military personnel and first responders to the threat of chemical warfare agent exposure.

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