

Science of the Skin and Respiratory Tract, and Related Countermeasures Pertinent to Chemical/Biological Defense

In Vitro Human Skin Model Evaluation of Dermal Decontamination Gel (DDGel)

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Aims: Determination of decontamination/detoxification efficacy and possible mechanistic insight of dermal decontamination gel (DDGel) to toxic chemicals including chemical warfare simulants in vitro human skin.

Experiment: DDGel composed of polymers (PVP/PVAc etc.), absorbent clays (fullers' earth etc.) and additional active ingredients (nanomaterials and metal organic frameworks) was investigated with C14 labeled chemical warfare simulants, drugs, and environment/industrial chemicals to evaluate decontamination efficiency (absorbance/ binding, reducing skin absorption and penetration) and detoxification capacity (acetylcholinesterase levels) in human skin in vitro models.

Results: DDGel competitively binds and absorbs chemicals with various physicochemical properties. It not only removes skin surface chemical residue but also reduces stratum corneum chemical reservoir. Deep tissue (systemic) penetration was decreased. DDGel also shows an important detoxification function – reducing acetylcholinesterase inhibition. Decontamination effect works on short dermal exposure (post 30 min or less) and longer time (1 – 2 hours) with some simulants. DDGel was more effective than RSDL (reactive skin decontamination lotion) in delayed decontamination (after 1 - 2 hours). This was evidenced in skin decontamination/detoxification experiments in vitro in human skin and in vivo mice models with organophosphate pesticide – paraoxon in which DDGel efficiency was significantly higher than that of RSDL ($p < 0.05$).

Conclusion: DDGel has similar behavior as human stratum corneum in binding and partitioning of chemicals with different hydrophilicity or lipophilicity. Porous character allows absorbing toxic chemicals. Moreover it can bond, hydrolysis, or destruct chemicals to reduce their toxicity. These functions may explain why it effectively works on delayed skin decontamination, especially in contaminated hairy skin with chemicals storage in hair follicles. Other important factors are: 1) DDGel formulation is easy to apply, quickly dries to form an easily peel off film, 2) DDGel's ingredients are low toxic potential, readily available, and low cost.

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