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Dermal Exposure as a Result of Glove Penetration

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Background

Dermal exposure is a primary route of occupational chemical exposure. Contact dermatitis, a health outcome caused by dermal exposure to chemicals, is one of the most common occupational illnesses and affects millions of workers each year. Dermal exposure can also contribute to the development of systemic disease [1].

Chemical-resistant gloves are the primary control measure used to protect against dermal exposure. Gloves are selected for use based on the time it takes for the chemical of concern to break-through the glove material [2]. Gloves are generally assumed to offer 100% protection against dermal exposure prior to break-through. There, are however, alternative mechanisms of glove failure that can lead to dermal exposure.

Aims

The overall aim of this research is to improve understanding of protection offered by gloves against dermal exposure. The **specific aim** of this study is to *characterize dermal exposure via chemical penetration of two glove types: long-cuff and short-cuff nitrile gloves.*

Methods

Participants (n = 10) were recruited and asked to simulate dishwashing in a tub using a 100-ppm fluorescein solution, once while wearing short-cuff gloves and once while wearing long-cuff gloves.

Primary outcome measures:

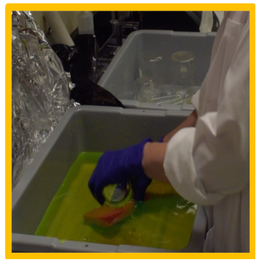
1) **surface area of contamination** measured from photographs of participants' hands under black light, and
2) **mass of contamination** measured as the fluorescein mass extracted from the hands using the glove juice method.

Statistical Analysis:

1) Compared left and right hands using paired t-test
2) Compared mass and surface area contamination using Pearson's correlation
3) Compared outcome measures between glove types using paired t-test
4) Descriptive statistics to summarize outcome measures by glove type

Results

DISHWASHING SIMULATION



BLACK LIGHT PHOTO OF CONTAMINATION

SHORT-CUFF GLOVE

LONG-CUFF GLOVE

Figure 1. Correlation between surface area of contamination (cm^2) and mass of contamination (μg).

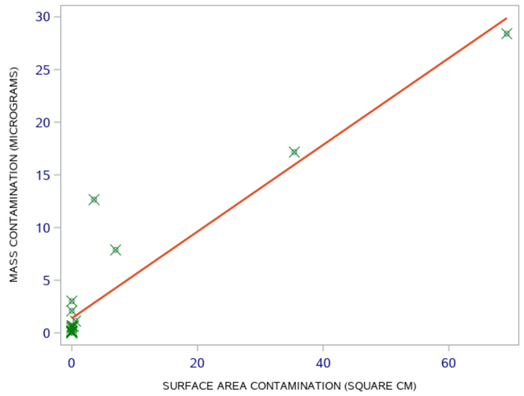


Table I. Comparison of contamination on left and right hands using paired t-test shows no significant differences.

Outcome Measure	Mean Difference	SD	P-value
Mass of Contamination (μg)	1.92	9.44	0.54
Surface Area of Contamination (cm^2)	9.44	21.72	0.20

Table II. Descriptive Statistics for total (right + left hands) dermal contamination outcome measures by glove type; paired t-test shows no significant difference between glove types.

	Short-Cuff Gloves				Long-Cuff Gloves				Paired T-Test	
Outcome Measure	Mean	SD	Range	% ND*	Mean	SD	Range	% ND*	Mean Diff.	P-Value
Mass of Contamination (μg)	2.81	4.19	0.05-12.7	0	4.73	9.88	0.007-28.4	0	-0.11	0.95
Surface Area of Contamination (cm^2)	1.08	2.35	0-6.97	60	10.52	23.4	0-69.2	70	1.58	0.69

*%ND is percent with non-detectable contamination

Limitations

- The study had a small sample size, limiting statistical power. An additional 10 participants performed the simulation with a 20-ppm fluorescein solution and those results were all non-detect.
- Future work will consider washing "style", tightness of glove at the wrist, and will examine gloves post-simulation for damage to glove material.

Conclusions

- The visible limit of detection for fluorescein contamination appears to be a mass of contamination of 5 μg (Figure 1).
- The short-cuff and long-cuff gloves resulted in the same amount of contamination.
- In the absence of permeation, dermal exposure occurred in this study indicating that material was able to penetrate the glove.
- Glove selection should consider penetration and permeation. A glove protection factor could capture glove performance on both of these dimensions [2].

References

1. CDC - Skin Exposures and Effects - NIOSH Workplace Safety and Health Topic. (2013). Retrieved from https://www.cdc.gov/niosh/topics/skin/default.html
2. Cherrie, J. W., Semple, S., & Brouwer, D. (2004). Gloves and dermal exposure to chemicals: proposals for evaluating workplace effectiveness. *Annals of Occupational Hygiene*, *48*(7), 607-615.

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