Permethrin: An Assessment of Exposure During Spray Application

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Abstract

Objective: Multi-route exposure assessment for permethrin during the manual treatment of military uniforms with 40% permethrin.

Background: Potential exposures to Working Party have not been studied and were not considered during permethrin safety label development. Working party typically only wear nitrile gloves for PPE and are not prescribed to maintain distance from spraying.

Fig 1. OVS-2 tube

Methods: Dermal sampling: dermal patches and dosimeter gloves analyzed potential exposure. Urine sampling: measured cis- and trans- 3-(2,2-dichlorovinyl)-2,2-dimethyl-(1-cyclopropane) carboxylic acid, or DCCA, as measure of absorbed dose. Air sampling: measured aerosol and vapor phases of permethrin with OSHA Versatile Samplers (OVS-2) (Fig 1.), and permethrin droplets with Florida Latham Bonds (FLB) rotating impactors (Fig 2.).

Results: Study showed no evidence that permethrin exposures to WP were different than to Applicator. Impactors found permethrin in air did not decrease when collected at increased distances from spray line.

Fig 2. FLB impactor

Conclusions: Findings showed the importance of PPE for WP and Applicators because potential exposures were not statistically different. Permethrin in air did not decrease within distances from spray line sampled in this study.

Introduction

DoD has used permethrin for the treatment of uniforms since 1980s for added protection from disease vectors. It can be applied to uniforms via factory application, manual spray application by certified applicators, and personal application methods.

Permethrin exposure during a manual spray is possible through ingestion, inhalation, and dermal routes. Two potentially exposed populations:

- **Applicators** (Fig 3.) - certified personnel assigned to mix, spray, and direct functions of a manual uniform spray event.
- **Working Party (WP)** (Fig 4.) - personnel assigned to assist with laying out, flipping, and collecting uniforms during a manual uniform spray event.

–Limited human data. Local or systemic potential health effects depending on exposure route, dose, duration, and individual variances.[3]

Fig 3. Certified Pesticide Applicator

Fig 4. Working Party

Methods

Uniforms were laid out in-line. Air samplers placed at distances from spray line at 0, 1, 2, and 3 feet from the downwind axis (Fig 5.).

Dermal[1] (n= 26)

- Cotton dosimeter gloves worn over nitrile gloves: NIOSH 9204 (draft, Fig 6.).
- α-cellulose patches (Fig 6.) on right forearm: OSHA in-house Method.
- *t*-test compared Applicator and WP means.

Urine (n= 29)

- Collected at baseline, 4-hour, and 12-24-hour.
- Tested for the metabolites *cis*- and *trans*- DCCA.
- Two-way repeated measures ANOVA to test if there were significant differences in mean DCCA.
- *t*-test compared the *trans:cis* isomeric ratio to indicate exposure route.

Air[2] (n=36)

- Two samplers: OVS-2 and FLB impactors (Fig 7.).
- OVS-2 tubes collect vapor and aerosol phases: OSHA Method 70.
- FLB impactors captured droplets in air: volume-weighted particle-size distributions at distance from spray line.
- Repeated Measures ANOVA: compared mean droplet volume between distances from spray line, the first and last 25% and middle 50% (Fig 5.).

Results

Dermal: This study did not provide evidence that dermal permethrin exposures, measured in gloves (p=0.83) and patches (p=0.45), are different between Applicators and WP (Tables 1. and 2.).

Urine: *Due to COVID-19 circumstances, urine has not yet been analyzed.*

Air:

- All values of permethrin measured on OVS-2 tubes below LOQ (0.4µg), indicating the need for longer sampling time or increased flow rate.
- The average droplet density was not statistically different (p= 0.39) between the sampling zones.

Table 1. Dermal Descriptive Statistics

	OBSERVATIONS (n)	MEAN (µg/sample)	ST. DEV.	MIN.	MAX
Applicators (Patches)	6	7.58	14.09	0.57	36
Working Party (Patches)	20	3.72	9.94	0.57	45
Applicators (Gloves)	6	14,065.00	7,314.45	610	49,000
Working Party (Gloves)	20	16,526.90	5,972.95	45	120,000

Fig 7. Environmental Sampling Rig

Table 2. Statistical Analysis Results

Method	Statistical Test	Comparison	p-value
Gloves	*t*-test	WP Applicators	0.83
Patches	*t*-test	WP Applicators	0.45
FLB slides	Repeated Measures ANOVA	Droplet volume-weighted density (Dv.1,Dv.5, Dv.9)	0.00
		Zone	0.39
OVS2	<LOQ	<LOQ	<LOQ

Conclusion

Permethrin exposures can occur from multiple routes during manual treatment events. Air monitoring for aerosol and vapor phases were inconclusive; all values reported below the LOQ. Impactors found permethrin in the air did not change within distances tested from spray line.

This study showed personnel participating in a uniform field manual spray treatment faced potential exposures to permethrin. Potential dermal exposures are not demonstrated between the Applicator and WP, yet only the Applicator is required to wear PPE. Findings confirm relevance of establishing a DoD SOP which specifically prescribes PPE requirements for all personnel and recommended distances for personnel from the spray.

References

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Disclaimers

This research protocol was approved by the USU IRB (USUHS.2019-032)

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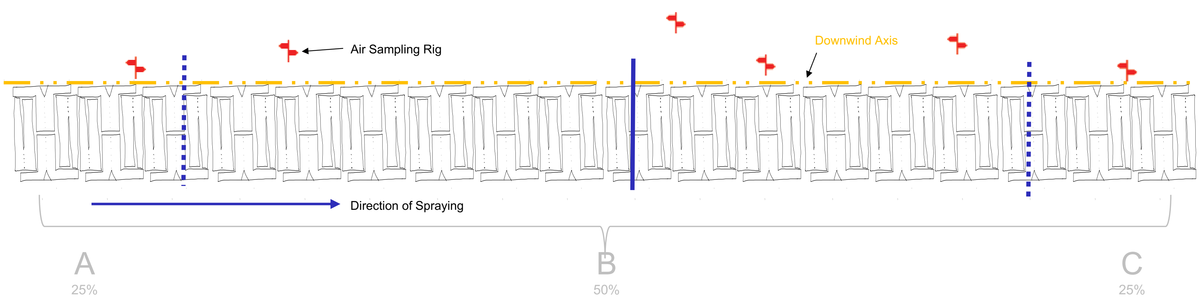

Fig 5. Spray-line layout