

Testing Dermal Exposure and Workplace Contamination of WUI Firefighters



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Introduction

WUI (Wildland Urban Interface) fires create a complex environment where wildland, structure, and vehicle fires merge. During these fire incidents, WUI fire fighters are exposed to numerous hazardous substances including chemical asphyxiates, Polycyclic Aromatic Hydrocarbons (PAHs), Volatile Organic Compounds (VOCs), and soot (Savolainen, 1998; Materna et al, 1992). These substances can cause serious health effects in humans including but not limited to cardiovascular disease, respiratory illnesses, cancer, and severe cases of asphyxia. Very little is known about the effects that this synthesis of harmful chemicals can have on WUI firefighters or the level of these exposures on surrounding equipment, working environment, and dermal exposure to personnel. The goal of this study is to: 1) improve our understanding of the exposure risks; 2) evaluate devices that can be used for assessing and predicting contamination hazards in the field; and 3) identify potential safeguards for improving firefighter health and safety with a focus on skin exposure and work place contamination.



Experimental Design

Fire Fighter Dermal Exposure Testing

Areas that will be sampled/tested: Face, neck, chest, back, forearms, hands, and thigh.

1. The surface of the face, neck, and hands will be tested using gauze wipes. (Liu et al, 2017)
2. Subjects will be dry wiped using a 1mm;10cm x 10cm gauze square on their skin.
3. All samples will be taken pre- and post-shift and duration of the shift will be recorded.
4. Samples will be analyzed using the HAPSITE ER Headspace system. Air VOC and PAH will be detected using sensors from WolfSense.

Fire Fighter PPE, Work Place, and Vehicle Surface Exposure Testing

This will be done to understand the potential exposure PPE introduces to the surrounding work environment/work surfaces (chairs, tables, interior of vehicles, etc.). Various surfaces of base camp and interior/exterior of work vehicles will be swabbed and analyzed to understand potential lingering exposure from PPE contamination on direct skin.

1. The surface of Fire fighter PPE and common areas will be tested utilizing the gauze wipe method.
2. 1mm;10cmx10cm gauze squares, will be used to wipe the sleeve, back, chest, and thigh region of PPE.
3. All PPE samples will be taken pre- and post-shift, with the duration of the shift and duty responsibilities noted. All samples will be labeled and stored in glass vials.
4. Vehicles and highly trafficked common areas (e.g. basecamp, eating areas, and incident command) will be taken at the end of the day.
5. Samples will be analyzed using the HAPSITE ER Headspace Gas Chromatography (GC) system. Air VOCs and PAHs will be detected using a separate unit to measure ambient conditions.



Methods

This study was designed following peer reviewed literature and recommended procedures developed by various agencies including OSHA, NIOSH, and EPA. Protocols were developed to provide the most practical and accurate methodology for in the field assessments of dermal and workplace exposure. Specifically, the peer reviewed literature and reports were researched to determine the most robust methods used to detect PAH and VOC contamination in firefighters. Literature related to dermal exposure assessment was limited, while there were abundant generalized studies that focused on PAH and VOC analysis in the environment. Finally, a rigorous search was conducted for potential in-field VOC and PAH analyzers. No current literature was found using portable VOC and PAH analyzers that tested for dermal / surface exposure. Search engines used to find the literature were CSUSM library search engine, Google Scholar, PubMed and Interlibrary loan.

Discussion

Studies on firefighter exposure to VOCs and PAHs are found throughout the literature, however studies specific to dermal testing of firefighters was limited, particularly for those working in the WUI. The research found on firefighter dermal testing either used devices in the laboratory to analyze their samples or sent the samples off to a lab to be analyzed. There were no studies that used field protocols or devices to provide a real-time analysis of VOCs and PAHs at an actual fire incident. This may largely be due to the fact that most analytical devices that can measure VOCs and PAHs are sensitive to the surrounding environment and require a laboratory-like setting in order to properly function. Those units that can be used in the field are somewhat cost prohibitive for most agencies and organizations.

Conclusions

Dermal testing of firefighters is a new field of research. Portable PAH and VOC analyzers have yet to be used during active duty for the purposes of assessing real-time dermal and surface exposure testing. A variety of portable GC analyzers exist, however upon closer inspection, few are practical for the use of dermal and surface analysis for firefighters. GC analysis has its limitations as well. The solvents typically used to transfer the VOCs to the instrument inhibit results and are often flammable (alcohol). This, in turn, makes them impractical for an active fire location. Advances in the type of solvent used or dry dermal swabbing can help correct these current limitations. Future studies should focus on devices that allow for in field investigation and analysis of dermal/surface samples.

Future Direction

- We hope to test this experimental design in Spring of 2018.
- Results from this experiment will be used to make recommendations for firefighter decontamination protocol that will help limit firefighter interaction with potentially dangerous VOCs and PAHs.

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