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# An evaluation of current working canine decontamination procedures and methods for improvement

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ABSTRACT

Working canines are often deployed to contaminated environments with unknown chemical and biological content. Little data exists supporting the effectiveness of current canine decontamination protocols. The objective of this study was to prospectively compare the effectiveness of a standard decontamination protocol utilized in real-world working scenarios by Federal Emergency Management Agency (FEMA) urban search and rescue teams (Protocol A) vs. a modified protocol (Protocol B) developed from technician feedback. Protocol A ($n = 7$) utilized stiff bristle brushes, generic pet shampoo, and a double rinse system. Protocol B ($n = 7$) utilized a soft rubber grooming brush, Johnson & Johnson's ® Head-to-Toe Body Wash, and a grated floor in addition to the existing rinse system to facilitate drainage of gray water. An oil-based pseudo-contaminant (Glo-Germ) was topically applied to four anatomical sites on each canine: the throat latch; between the shoulder blades; the inner aspect of the hind leg; and the hind paw. Reduction in contamination was assessed after each canine underwent decontamination and scored using a previously validated scale. Categorical data were analyzed using a Chi Square test and PROC FREQ of SAS (version 9.4). Overall, Protocol B was associated with greater reduction in contamination compared to Protocol A ($P = 0.01$), with the throat latch and inner hind leg more likely to retain contaminant than the hind paw or between the shoulder blades ($P < 0.01$). Canines decontaminated using Protocol A were more likely to have residual contamination of the throat latch or inner hind leg compared to the hind paw ($P < 0.05$). In contrast, those decontaminated using Protocol B were likely to have residual contamination of only the throat latch compared to other sites ($P < 0.05$). Simple modifications in current FEMA protocols increased the overall effectiveness of working canine decontamination.



## Introduction

Working canines are frequently deployed into contaminated environments as part of search, rescue, and recovery operations (Slensky et al., 2004; Fox et al., 2008; Otto et al., 2010).

Compromised infrastructure and sanitation can expose canine responders to a wide range of chemical, biologic, and/or radiologic hazards resulting in significant morbidity and mortality. Hazards that canines may be exposed to include aerosolized or dust particles that may cause eye irritation; standing water that may include antifreeze, gasoline, oil, or other chemical agents; protozoal or bacterial organisms, including *Giardia* sp, *Leptospira* spp, and coliform bacteria, as well as other hazards that may not be known at the time of the response (Otto et al., 2002; Murphy et al., 2003; Wade et al., 2003; Wismer et al., 2003; Fitzgerald et al., 2008; de Man et al., 2014; Gordon, 2015). Agents readily transmitted

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through direct contact with a contaminated canine may in turn impact human responders, increasing the scope of the exposure.

Decontamination is the process of removing and/or neutralizing the spread of a contaminating agent (Federal Emergency Management Agency [FEMA], 2012). Gross decontamination may be classified as either technical or gross. Gross decontamination is the immediate reduction of potentially life-threatening contaminants in the field. This may simply involve rinsing an exposed body site with copious amounts of water. In contrast, technical decontamination involves the construction of an elaborate decontamination corridor. This corridor must be staffed by hazardous material technicians and includes scrub stations, double rinse systems, showers, and an area to doff contaminated personal protective equipment. This facilitates the systematic removal of contaminating agents by physical and/or chemical means. As working canines can neither doff a contaminated coat nor presently be outfitted in full personal protective equipment, canine decontamination focuses primarily on diluting and washing away any contaminating agents. Surprisingly, little evidence exists to support best practices for the technical decontamination of working canines. Although a standard decontamination protocol for FEMA working canines has been adapted from human processes (Department of Homeland Security [DHS], 2012), the effectiveness of this protocol has never been formally investigated using live animals operating under real-world working conditions. We sought to assess the effectiveness of the existing FEMA canine decontamination protocol as implemented in real-world operation scenarios and compare it against that of modified protocol.

## Materials and methods

### *Animals*

The research study was approved by the Southern Illinois University Institutional Animal Care and Use Committee. Twelve FEMA-certified canines (FEMA, 2008) from Florida Task Force 1 and Florida Task Force 2 urban search and rescue teams were separated into 2 groups for participation in this blinded 2-day prospective study. Breeds included Labrador retrievers, golden retrievers, and Belgian Malinois. Each dog was randomly assigned to 1 of the 2 decontamination protocols with 2 dogs participating on both days of the study. For dogs participating on both days, preapplication scanning confirmed the lack of any residual agent from the prior day. Standards for animal care were adopted from previously published recommendations (Prescott et al., 2004). Animals were fed commercially available complete and balanced dry kibble diets twice daily at approximately 0600 and 1700. Canines were transported to the training facility and housed in individual kennels for the duration of the scenario.


**Figure 1.** Anatomic sites on working canine where an oil-based pseudocontaminant was applied to simulate contamination: (1) throat latch, (2) between the shoulder blades, (3) inner aspect of the right hind leg, and (4) the left hind paw.

### *Simulated contamination*

A commercially available pseudocontaminant (Glo Germ, Moab, UT) powder was used to simulate environmental contamination of canines. The powder was mixed with mineral oil at a ratio of 6:10 to create an oil-based contaminant based on manufacturer's recommendations. This pseudocontaminant was invisible to the naked eye but readily visible under ultraviolet illumination and has been utilized in prior studies examining contamination in hospitals. Approximately 10 mL of the pseudocontaminant was applied using a small round paint applicator (Momenta, Portsmouth, UT) in a single touch over an approximately $4 \times 4$ cm area at 4 anatomic sites on each canine: (1) the throat latch, (2) between the shoulder blades, (3) the inner aspect of the right hind leg, and (4) the left hind paw (Figure 1). These areas were selected based on their relatively large surface area and perceived likelihood of direct contact with environmental contaminants during standard FEMA operations. After contamination, each canine participated in an urban search and rescue scenario (approximately 60 minutes of rubble search with no water exposure) as part of a scheduled training exercise. The search time was included to allow time for the contaminant to saturate the surrounding areas and because when operating under real-world conditions, it is unlikely that the canine would be decontaminated right away during search operations. Without evidence that there was a high concern for chemical agent exposure or some other type of life-threatening hazard, it is far more likely that the canine would be decontaminated at the completion of their shift.

On completion of the exercise, each canine reported to the decontamination station. Canines participating on day 1 of the study were decontaminated using protocol A; those participating on day 2 were decontaminated using protocol B. Different hazardous material technicians ($n = 6$/day) performed decontamination on days 1 and 2 in an effort to prevent bias that may result after conversations that may occur after the exercise. All technicians were trained according to the FEMA standard and were blinded to the type of cleanser used and the locations of contamination.

Canines assigned to protocol A ($n = 7$) were decontaminated using stiff bristle brushes (Figure 2A) and a generic pet shampoo as part of a multistep process recommended by the DHS (DHS, 2012). This multistep process uses an initial gross decontamination step (Figure 3A) followed by a second wash using a double rinse system (Figure 3B). Protocol A is the currently accepted FEMA standard for working canine decontamination.

Canines assigned to protocol B ($n = 7$) were decontaminated using a soft rubber grooming brush with long rubber bristles (Figure 2B) and Johnson & Johnson's Head-To-Toe Body Wash (Johnson and Johnson Consumer Products Company, Skillman, NJ) with the addition of a grated floor (Figure 3C) to facilitate drainage of gray water during the same multistep process used in protocol A. Protocol B was developed after discussions with experienced

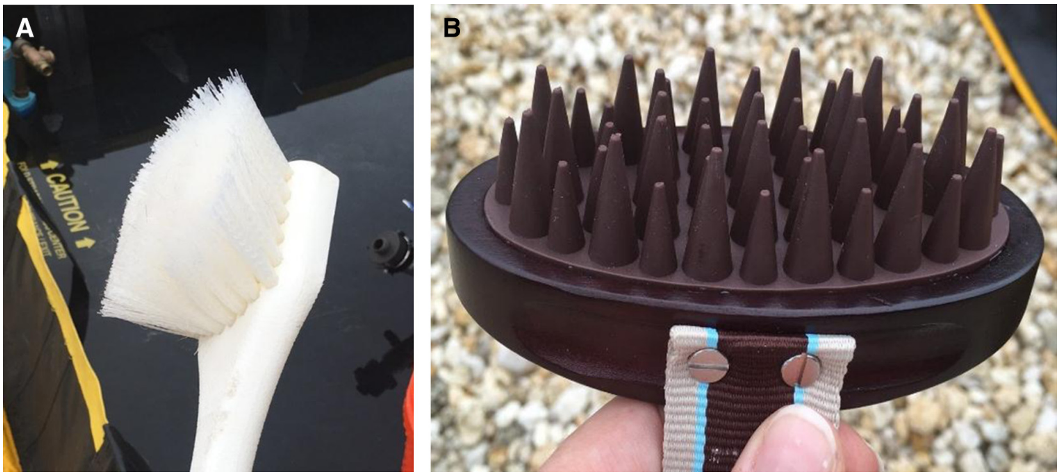


**Figure 2.** (A) Stiff bristle brush used as part of the current Federal Emergency Management Agency canine decontamination procedure (protocol A). (B) Soft rubber grooming brush used as part of a modified decontamination process (protocol B).

hazardous material technicians (n = 6) and their expert opinion of effective canine decontamination. Cleanser used for protocol B was selected based on results from a smaller validation study conducted before this study (Supplemental Appendix).

Pre- and post-decontamination images of each of the 4 anatomic sites were captured digitally using a Nikon 1 J1 (Nikon Corporation, Minato-ku, Tokyo) camera, while a light-emitting diode ultraviolet flashlight (The Bramton Company LLC, Dallas, TX) was held approximately 18'' away from the contaminated site. Reduction in contamination (fluorescence) was scored on a scale of 0-3 as previously described (Lee and Lee, 2014) (Figure 4) based on a later review of the images. Digital image scores were assigned by 2 blinded reviewers with 94% agreement. None of the score discrepancies between reviewers were >1. A score of 0 denoted <25% contaminant reduction; a score of 1 denoted 25%-50% contaminant reduction; a score of 2 denoted 51%-75% contaminant reduction; and a score of 3 denoted >75% contaminant reduction.

Data entry was performed using Microsoft Excel (Microsoft Corporation, Redmond, WA), and data were analyzed using SAS, version 9.4 (SAS Institute Inc, Cary, NC). Categoric variables were compared using $\chi^2$ test. $P$ values $<0.05$ were considered significant. Effective decontamination was defined as a reduction in fluorescent marker contamination by 50% or greater or a contaminant reduction score of 2 or greater.


**Figure 3.** (A) Initial gross decontamination step used in current Federal Emergency Management Agency canine decontamination procedure. (B) Second wash step of gross decontamination for working canines using a double rinse system. (C) Grated flooring used during protocol B to physically separate the working canine from pooling gray water and facilitate its drainage.

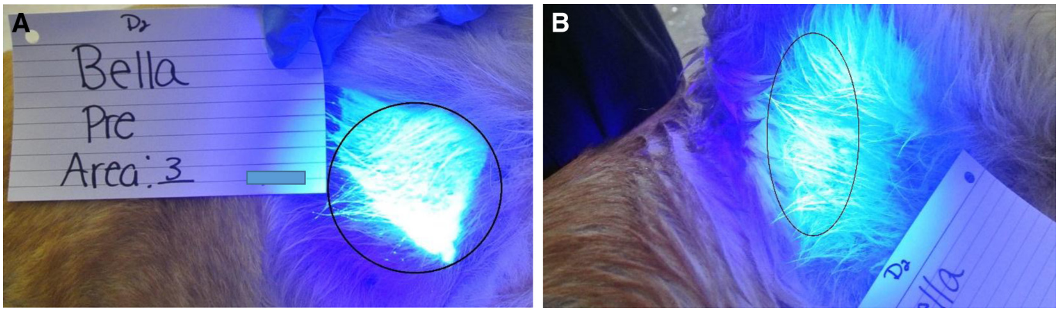


**Figure 4.** Pre- and post-decontamination images of the shoulder blades under ultraviolet illumination. Significant residual contamination at this site, as demonstrated by persistent areas of fluorescence despite decontamination of this working canine, resulted in a score of 0 (0%-25% reduction in contamination). (A) Pre-decontamination. (B) Post-decontamination.

## Results

Significant differences in contamination reduction scores were identified by protocol and anatomic site. Canines that underwent protocol A were less effectively decontaminated compared with those that underwent protocol B ($P = 0.01$). When differences in contamination reduction were examined by anatomic site for working canines participating in protocol A, the throat latch (location 1) and hind leg (location 3) remained significantly more contaminated than the hind paw (location 4) and between the shoulder blades (location 2) ($P = 0.02$) (Figure 5). In contrast, only the throat latch remained significantly more contaminated compared with the other 3 sites among working canines participating in protocol B ($P = 0.04$). Protocol B was more effective at overall decontamination (>50% contaminant reduction) ($P < 0.05$) compared with protocol A (Figure 6).

## Discussion

Our study describes the use of an oil-based fluorescent marker to simulate exposure to a contaminant during urban search and rescue operations and evaluate the effectiveness of 2 working canine decontamination protocols. Little if any data exist to support or validate current decontamination practices on live animals under real-world conditions.

We found that a modified protocol (protocol B) was more effective than the current FEMA canine decontamination procedure (protocol A) in removing an oil-based pseudocontaminant. Use of a soft rubber grooming brush in protocol B may have provided greater comfort and ability to lift the working canine's fur to remove contaminants in comparison to the stiff-bristled brush used in protocol A. The stiff-bristled brush that was used during protocol A is an item that is part of the decontamination equipment but is not designed for use with canines. Use of a mild body cleanser (Johnson & Johnson's Head-To-Toe Body Wash) in protocol B that was perceived as less irritating (particularly to the eyes and face) than generic pet shampoo may have facilitated more thorough washing of the working canine by hazardous material technicians. Finally, the addition of a grated floor in protocol B to physically separate the working canine from pooling gray water and facilitate its drainage may have reduced the risk of recontamination of the working canine as the multistep decontamination process proceeded.

Significant differences in contaminant reduction were observed by anatomic site across protocols. Both protocols scored poorly when it came to reducing contamination of the throat latch. This may be explained by the fact that working canines are often fitted with highly individualized collars and leashes made from nylon, leather, or other porous materials capable of absorbing and retaining contaminants. This equipment was not removed during decontamination and may serve to reintroduce contaminants to the throat latch. Although it is likely that failure to remove this equipment contributed to persistent contamination, it is important to note that this error was committed across both days with 2 independent sets of technicians conducting decontamination. Although having 2 sets of technicians could be viewed as a limitation to the study, it also confirmed a lack of compliance with current recommendations because both sets of technicians failed to remove equipment before decontamination. Therefore, as one of our study objectives was to assess the effectiveness of the current FEMA protocol as implemented in the field, we chose not to interfere in their professional capacities. Clearly, this indicates a need for specialized training specific to canine

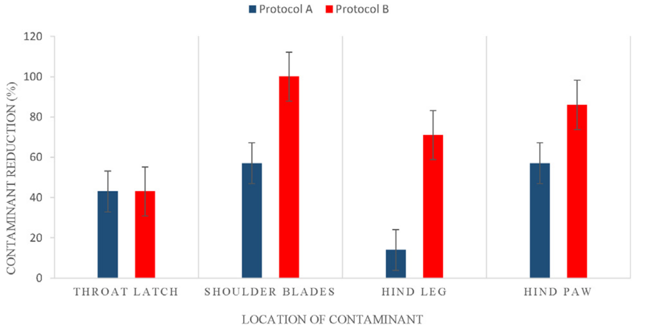


**Figure 5.** Contaminant reduction by anatomic site after decontamination with protocol A versus protocol B. Effective decontamination was defined as a reduction of 50% or greater in residual contamination. Overall, protocol A was less effective at contamination reduction across anatomic locations examined ($P = 0.0044$).

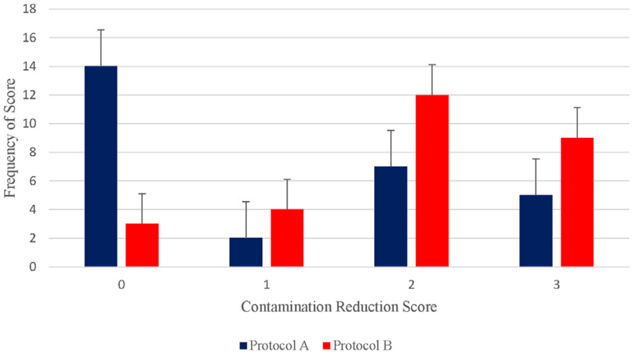


**Figure 6.** Contaminant reduction scores after decontamination with protocol A versus protocol B. Protocol B was associated with higher contamination reduction scores compared with protocol A ($P = 0.0166$). *Note*: Contaminant reduction score of 0 = <25% contamination reduction, 1 = 25%-50% contamination reduction, 2 = 51%-75% contamination reduction, and 3 = >75% contamination reduction.

decontamination. Furthermore, future investigations should include complete removal of all equipment and a separate process to decontaminate these items if they are to be reused.

A major limitation of our study was its small sample size and the variability in working canine breeds recruited to participate. It is possible that certain types and lengths of canine hair could retain the pseudocontaminant more readily than others. Apart from training exercise duration, we did not strictly control for physical activity undertaken by the working canine that could have removed pseudocontaminant before formal decontamination (e.g., crawling through confined spaces, rolling in the grass). Contaminant reduction was scored based on a qualitative rather than quantitative inspection, which could have been influenced by observer bias. Finally, as protocol B introduced several new simultaneous modifications to the current FEMA standard (use of a soft rubber grooming brush, mild body cleanser, and grated floor), we were unable to determine whether any one specific component could have accounted for most of the improvement in contaminant reduction observed.

Ineffective decontamination of working canines after exposure to a disaster environment with unknown chemical and biologic hazards can pose a considerable threat to canine health. Solid and liquid toxicants encountered in urban disasters involving collapsed structures can include a wide range of organic compounds (e.g., hydrocarbons, polychlorinated biphenyls, glycols, phenols, other solvents), acids, alkalis, oxidants, and heavy metals (Gwaltney-Brant et al., 2003). Floods can disperse toxicants concentrated in the environment, including pesticide residues in sewage drainage, canals, and rivers (Euripidou and Murray, 2004). Although most dermal chemical exposures result in direct injury or irritation to intact skin, lipophilic agents can be absorbed through the skin leading to systemic toxicity. Canine self-grooming behavior can result in ingestion or inhalation of toxicants after skin surface and hair contamination. In the setting of flooding and poor sanitation, waterborne pathogens, including *Salmonella*, *Shigella* spp, *Giardia lamblia*, and *Leptospira*, can cause disease in canines through ingestion of contaminated water; it is conceivable that self-grooming behaviors could contribute to infection as well. Working canines share close contact with human disaster responders and could potentially spread a chemical contaminant or biologic pathogen if not adequately decontaminated after operations in a disaster setting. In view of these considerations, effective working canine decontamination must remain a priority in maintaining the health and safety of the canine disaster responder. Unfortunately, construction of the decontamination corridor is time and labor intensive. Portable field decontamination kits would be beneficial and could contain emergency decontamination supplies to facilitate quick removal of identified contaminants without the need for elaborate decontamination structures. This may help to maximize the removal of environmental contaminants and minimize cross-contamination to human teammates. FEMA canines may be deployed for up to 14 days with repeated field exposure to contaminants. Further studies analyzing the long-term effects of repeated washings with different shampoos need to be conducted to evaluate the impact on the acid mantle of the canine dermal layer, which has a lower pH than that of humans (Matousek & Campbell, 2002).

Our study was limited to the investigation of decontamination effectiveness associated with oil-based contaminants. Because of the lack of published evidence associated with canine decontamination, it was an important step forward as petroleum-based compounds are hazards that working canines are frequently exposed to. Future studies should investigate methods associated with decontamination for microbiologic agents and other types of chemical compounds (non-oil-based). In addition, this study provided an important measure of the effectiveness of the current recommendations as applied in the field. Clearly, there is a need for improved training for canine-related decontamination.

In summary, simple modifications to the existing FEMA decontamination protocol, including the use of a soft rubber grooming brush, mild body cleanser, and grated floor, significantly improved the overall effectiveness of contaminant reduction as applied in a field scenario. Removal of all equipment (including the collar and leash) followed by a systematic top-down and front-to-back approach to washing and rinsing may further enhance effectiveness. Future research and innovation are needed to optimize canine decontamination processes and develop protocols for improved decontamination in the field. In addition, standardized training to improve the application of decontamination protocols for working canines is needed to maintain the consistency of results.

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## Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jveb.2017.07.008.

## Ethical considerations

All works described were approved by the Southern Illinois University Animal Care and Use Committee.

## Conflict of interest

The authors declare no conflicts of interest.

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