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K9 DECONTAMINATION

Guidelines for Emergency, Gross, and Technical
Decontamination of the Working Canine



2024 Revision and Updates

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INTRODUCTION

During the course of a search or other work, canines may be exposed to hazardous materials. Exposure to contaminants can range from the most benign dirt to drugs to potentially life-threatening hazardous materials and weapons of mass destruction, including chemical, biological, and radiological substances. They are encountered during natural disasters like floods, hurricanes, and earth quakes, human-made accidents like fires and explosions, terrorist events, or in the course of a regular days' work.

These contaminants may come in several different forms, including solids, liquids, powders, and gas. Search and rescue operations involve the sorting of collapsed materials, aerosolizing any hazards that may otherwise settle during a deployment. Working without the personal protective equipment that humans use, a working canine's risk of exposure is increased. In addition, many hazardous materials are heavier than air and tend to pool low to the ground, where canine exposure is high.

Decontamination of animals is an important component of responsible emergency response management and is a recognized part of an emergency response plan. The importance is for the health and well-being of the animals affected as well as the humans to whom they may transmit hazardous materials. Having a system on site with the ability to adapt to a range of needs, from benign to emergent, is important. In the field, having a portable emergency decontamination kit may save the life of a canine and those around them.

This document is designed specifically as a guide to the practical, day-to-day operations of providing a means of decontaminating a canine in the variety of situations that may occur. Many resources of information developed by others' work were investigated and included. All resources are listed at the end of the paper.

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LEARNING OBJECTIVES

- Reasons for Decontamination of Working Canines
- Categories of Decontamination
- Canine-Specific Challenges
- Routes of Exposure for the Canine
- Decontamination Field Operations
- Decontamination Systems Models
- Scientific Studies in Decontamination Training
- Chemical, Biologic, and Radiologic Canines Exposure Effects
- Real World Decontamination Operations
- Decontamination Equipment, Supplies, Kits

WHY DECONTAMINATE WORKING CANINES

Health and Well Being of the Canine

- Personal Protective Equipment (PPE) during operations is minimal
 - Face, belly, limbs, paws most vulnerable
 - Eye protection helps but need nose, mouth to scent
 - Booties protect but decrease agility in rubble
- Search work is close work
 - Closer to contaminants that settle on/near ground
- Exposure effects mild, moderate, life-threatening
 - Factors: strength, dose, exposure time of contaminant
 - Varied effects for inhalation, ingestion, injection, absorption, contact

Health and Well Being of the Team

- Contaminated K9s can transmit Hazardous Materials to others:
 - During operations to handler
 - Contact with other team personnel
 - Bring back to kennel, base of operations
- Fulfills goal to bring every team member home safe and healthy



Dogs of War

DECONTAMINATION CATEGORIES FOR THE WORKING K9

External ~ 🐾 ~ Internal

External – Removal of contaminant from the outer body; the main focus of this document

Internal - Removal/elimination/antidote of contaminant that has gained access inside the body (lungs, gastrointestinal tract, urogenital tract, vascular/blood, neuromuscular system)

Gross ~ 🐾 ~ Technical

Gross

- Removal of bulk of the contaminant as quickly as possible
- Initial phase of decontamination process during which the bulk amount of surface contaminant is significantly reduced

Technical

- Detailed removal of all contaminant or remaining after initial or gross decontamination
- Process involves an established corridor, specific stations, and detailed guidelines designed for complete removal of contaminants, leaving no residual hazard, and addressing the medical needs of victims and responders as needed
- Meticulous process to remove as much contaminant as possible utilizing several methods such as wiping, vacuuming, adsorption, absorption, washing, chemical detoxification, chemical neutralization, and others.

Whole Body ~ 🐾 ~ Targeted

Whole Body

- Decontaminating entire body or large areas

Targeted Area(s)

- Target-specific area decontamination
- Decision based on exposure and risk assessments
- Most frequently exposed areas: paws/paw pads, lower limbs, ventral abdomen (belly), and face



Dean Scott & Booter

Mud splatters exhibit common contamination areas on canines

Emergent ~ 🐾 ~ Nonemergent

Emergent

- Contaminant removal is a lifesaving process
- Unknown substance considered emergent until proven otherwise
- The need and ability to medically treat a canine before reaching the decontamination corridor is based on several factors: a life-threatening status, medical personnel presence within the hot or warm zone, on site medical supplies, and safety of involved personnel
- Contaminant removal may be the most important medical treatment

Nonemergent

- Less urgent (but still important) removal of non-life-threatening contaminant
- Non-emergent does not mean unharmed

CANINE-SPECIFIC ASPECTS OF CONTAMINATION

This section considers the canine viewpoint of contamination, including

- Anatomy
- Routes of Exposure
- Species Behavior
- Risk Factors
- Metabolism
- Sensitivities

Ocular Exposure

- Situation
 - Eye PPE typically absent
 - Head is low to ground where dust, debris, contaminants settle
 - Sniffing aerosolizes particulates in front of eyes (and mouth)
 - Third eyelid/nictitans (and open mouth) trap debris, hazardous substances
- Management
 - K9's own tears and blink mechanisms clear debris
 - May not be fast enough to deter some harmful effects
 - Flushing eyes with warm (keep in pocket) eye rinse
- Preventive Measures
 - Eye Protection
 - Work like you train, train like you work

Inhalation Exposure

- Situation
 - Scent is K9s highest functioning work tool
 - Respiratory protection inhibits this primary sense
 - Inhalation exposure potential high as many contaminants settle on the ground where they do much scenting, aerosolizing some substances
- Advantages
 - Nasal long length and intricate inner scrolling
 - Traps many particles before reaching lungs
 - Can sneeze out contaminants
 - Lungs have strong defense cell mechanisms
- Disadvantages
 - Very vascular nasal mucosal lining
 - Absorption of contaminants may occur



Dogs of War

Ingestion Exposure

- Situation
 - Open mouth while scenting collects debris inside which is swallowed
 - K9s open their mouth to bring scent behind soft palate to use vomeronasal olfactory organ and/or panting from excitement or to cool down
 - Deliberately ingest contaminated food/water (hunger and thirst driven?)
 - Aerosolizing contaminants during scenting may settle around mouth and nose; natural instinct to lick face, lick fur clean
- Management
 - Training: discourage food and standing water ingestion
 - Maintain hydration, work drive
- Preventive Measures
 - Periodic targeted wipe cleansing of face, limbs, body during operations

Dermal Exposure

- Situation
 - Body not typically clothed in PPE
 - Hyperthermia concerns in heat even if K9 cooling is via panting
 - Vests protect torso but head, belly, limbs, paw pads vulnerable
- Advantage
 - Skin protected by hair/fur trapping particles
 - Chemical War Agents (CWAs) tested on fur samples did not quickly wick down the fur to skin
- Disadvantages
 - Vulnerable areas with minimal fur: axillae, flank, scrotum, paw pads, nasal planum, inner ear pinna
- Management
 - Periodic wipe decontamination during operations
 - Additional decontamination end of shift
 - For life-threatening hazard exposures, a Canine Field Decontamination Kit was developed by military-sponsored research and development group (details under dry decontamination methods)



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Paw Pads Exposure - Uniquely protective and vulnerable

- Advantages
 - Tough, thick pads protect from blunt injury and varied temperatures
 - Traction and manipulative ability for uneven surfaces and agility
- Disadvantages
 - Sweat glands in pads are vulnerable to toxin absorption
 - Crevasses challenging to decontaminate
 - High level potential exposure unbooted
 - Heat trauma (post fire search) and wound trauma (most common area of insult) increase vulnerability for exposure and absorption
- Management
 - Frequent paw pad checks (angle paws backwards or have K9 lie down)
 - Bandaging painful/injured paws so K9 continues operations
 - Wipe pads as need but if wet: dry well to prevent increased dust/debris collection or 'caking' on pads
- Preventive Measures
 - Booties, bandages
 - Inner tube from motorcycle tires for heat protection (post-fire debris)
 - Temperature check surfaces with which they come in contact

K9 Protective Bandaging

- Developed during the Oso, WA Landslide deployment in 2014 and used by handlers in multiple home-based searches, including post-fire heat/ash surfaces
- Multiple inner padded layers enveloped by stretch layers allow for paw and limb expansion so as not to decrease blood flow to the paws while more restrictive protective outer layers prevent mud, water, and debris from reaching the limb and secure booty
- Seven Potential Layers
 - Stirrups = tape placed against fur (animal bandaging secret weapon)
 - Wound treatment layer with gauze if needed
 - Cast padding/cotton layer
 - Stretch gauze roll, minimum 3"
 - Vet wrap = stretch, water resistant
 - Elastikon™ = tough stretch tape
 - Duct tape only if enough padding beneath

} PADDING
 } STRETCH LAYERS
 } SECURE & PROTECT



Bandage Booty Application Steps



Dean Scott & Booter

Search Operations
 Oso, WA Landslide circa 2014

K9 Protective Tire Tubing

The inner tubing from motorcycle tires was cut and slipped onto canine paws and lower limbs to protect them while performing search operations due to the potential for hot ash beneath the surface of the grounds and rubble.

- Motorcycle inner tubes are typically made from a combination of natural and synthetic rubber. Butyl rubber, a synthetic elastomer made from isobutylene and isoprene, is the most common type of inner tube used today. Butyl rubber is more flexible than natural rubber, ages better, and is slightly more resistant to punctures. It's also very elastic and holds air well
 - They come in various thickness and diameters
 - Securing with Elastikon™, a sticky stretchable tape, allows for swelling and movement of the canine limb that will not compromise blood supply
- Leaving the digits (toes) open allows for air flow and debris that gets in there to fall out



Inner Tube Booties on K9 Mazie



K9 Mazie, Search Operations Maui, HI

Photos Courtesy Handler Eric Darling

Injection Exposure

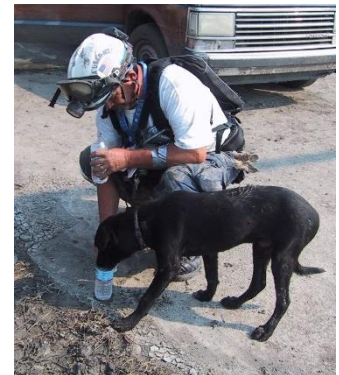
- Situation
 - Transdermal wound entry of contaminant into body
- Disadvantages
 - Fur/hair may make hide wounds
- Management
 - Body checks pre, during, post operations (especially paw pads)
 - Wound treatment as needed
 - Protective coverings
 - Internal decontamination as needed
- Preventive Measures
 - PPE that does not limit capabilities

Contamination Preventative Measures

- Body checks during operations
 - Medical checks by Handler
 - Particular attention to limbs and paws and pads
- Targeted decontamination during operations
 - Wiping visual areas of contamination
 - Paw pads dry well to minimize debris sticking to them
- Limited PPE
 - Vests, booties or search bandages, eye/ear protection
 - Train in PPE 'Train like you work, work like you train'
- Adequate Work-Rest Cycles
 - Minimizes fatigue, injury, illness
 - Maximizes efficiency, safety, accuracy
 - Maintains strength throughout shift
 - Fatigue #1 reported search K9 issue at OKC, WTC
- Hydration
 - Maintains health, efficiency, accuracy
 - Minimizes survival need to drink from unknown source when thirsty
- K9 Health Maintenance
 - Weight, strength, cardio, and nutrition maximize health
 - Minimizes injury, illness, and difficulties during operations

K9 Hydration

- Water maintenance
 - ~2-4 ml/kg/hr (~ 3 liters/day 35-40 kg K9)
 - Increase as needed for heat, humidity, and workload
- Monitor Hydration Status
 - Moist mucous membranes
 - Gum color when pressed returns in 1-2 seconds
 - Normal urination and color
 - Skin when pinched immediately flattens



Hurricane Katrina 2005

- Pre-work Hydration Loading
 - Subcutaneous fluids (Normal Saline, Lactated Ringer’s) administration
 - Average 500 ml placed under the skin between the shoulder blades
 - 18-gauge needle insertion into a cleansed space so do not introduce bacteria/debris
 - May delay dehydration but does not take the place of oral hydration needs throughout an operational period



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DECONTAMINATION FIELD OPERATIONS

Decontamination Basics for powders, liquids, caked-on matter

Decontamination and water-reactive chemical

Decontamination and soaps

Canine Considerations

Human Safety

Handler Down

Removing Varied States of Matter

For all situations:

If contamination is of unknown identity, consider it harmful/toxic until proven otherwise.

Anyone handling the canine should wear protective gear.

Remove all contaminated canine equipment (leash, collar, vest, booties, eye protection)

Contain canine with uncontaminated collar/leash or slip lead

- Powder contamination
 - Avoid brushing which cause aerosolization, creating inhalation exposure risk
 - Wet/Moist towel for initial gross removal by trapping particles
 - Dry towel to absorb remaining liquid with trapped particles
 - Repeat as needed
 - Sticky paper/rolls another option to attract particles off the canine
 - Technical removal if needed should there be skin exposure despite initial external gross decontamination; options include
 - High water/low pressure system – after initial removal so as not to drive particles to the skin
 - Low water/toweling soap and rinse – sponge bath concept
 - Decontamination pads – plain, treated, antidotal; manufactured, microfiber towel, other towels
 - Wet-dry vacuum system – uses Accelerated Hydrogen Peroxide solution
 - Dry vacuum system – extreme cold weather operations

- Clay/caked-on contamination
 - Non-toxic contaminant
 - Break down with a non-toxic substance for easier more efficient removal (mechanic soap, mineral oil, liquid detergent)
 - Light pressure so as not to drive further into canine fur
 - Scrape off with putty knife or similar scraper
 - Toxic contaminant
 - Scissors to remove the outermost section of contaminated fur; scissors tip to angle away from canine
 - Use a Wet/Moist towel by pinching the remaining fur and milking the contaminant away from the skin, in the direction of the fur; for large areas gently rub against the direction of fur growth to lift the fur
 - Dry towel to absorb remaining moistened substance
 - Repeat as needed
 - Technical removal if needed should there be skin exposure despite initial external gross decontamination; options include
 - High water/low pressure system – post initial removal so as not to drive particles to the skin
 - Low water/toweling soap and rinse – sponge bath concept
 - Decontamination pads – plain, treated, antidotal; manufactured, microfiber towel, other towels
 - Wet-dry vacuum system – uses Accelerated Hydrogen Peroxide solution
 - Dry vacuum system – extreme cold weather operations

- Liquid contamination
 - Dry towel absorption by pinching the fur and milking the contaminant away from the skin, in the direction of the fur; for large areas gently rub against the direction of fur growth to lift the fur
 - Additional adsorption options include application of flour, baking soda, diatomaceous earth, then treat as a caked-on substance removal
 - Wet/moist towel to absorb residual liquid using same light/gentle pinching of the fur method to decrease driving substance toward the skin
 - Dry towel to absorb remaining liquid
 - Repeat as needed
 - Technical removal if needed should there be skin exposure despite initial external gross decontamination; options include
 - High water/low pressure system – post initial removal so as not to drive particles to the skin
 - Low water/toweling soap and rinse – sponge bath concept
 - Decontamination pads – plain, treated, antidotal; manufactured, microfiber towel, other towels
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Water Reactive Chemicals

- Solid or liquid chemicals have violent reactions when exposed to water
- By interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities
- Liquids
 - Blot with dry towels, microfiber towels, high absorbency
 - Absorb with benign powder (flour, baking soda)
 - Wipe off by gently pinching contaminated fur away from the skin in the direction of the fur if a small area; for larger areas go against the direction of fur growth to lift the fur and remove contaminant
 - Repeat as needed
 - Wet-Dry vacuum? Unknown/untested theoretical removal

Decontamination Soaps

- Soap Pros
 - High pH neutralizes many chemicals
 - Dissolves petroleum, oil-based products
 - Trisodium EDTA in Johnson's® Baby Shampoo chelates some of the heavy metal ions and radiologic isotopes
 - Inexpensive and currently readily available
- Soap Cons
 - Repeated use breaks down K9 protective dermal oils
 - In one study (Discepolo, et. al) Repeated daily bathing with dilute dish detergent significantly reduced normal healthy dermal microbial taxa and created significant changes in the dermal microbiota of canines. Disruption to the canine dermal microbiota may cause negative impacts to canine dermal health and require further investigation
 - Dry skin becomes pruritic (itchy), scratching ensues, wounds skin
 - Wounded skin may become infected (superficial dermatitis or 'hot spots') or become an access for HAZMAT absorption
 - Dishwashing liquids extremely sudsy, difficult to rinse off completely; consider diluting with water before application or using less volume
 - K9 specific moisturizing shampoos an option to maintain/restore skin protective oils
 - Requires high water decontamination unless targeting high-risk areas (legs, paw pads) and can use less water



Dogs of War

K9 Considerations and Notes

- Weather
 - Hot, humid weather mitigated by water cooling
 - Water potential to create/worsen hypothermia in the cold
 - Cold weather water decon needs shelter, heat, and meticulous drying of K9
 - Extreme cold weather operations may require dry vacuum system option
- K9 Head/Face
 - Eyes especially sensitive to contaminant, soaps, decontamination solutions
 - Water in ears needs shaking out or infection may ensue
- Hair Clipping
 - Radiation monitoring after decontaminations and canine is still 'hot'
 - Clip hair at targeted areas of residual radiation
 - Human-type razors harmful; scissors use with caution (dull tips, angle away from skin; animal clippers and grooming blades best suited to prevent skin wounding)
- Paw Pad Attention
 - Documented in illness and injury data studies to be the most highly contaminated area
 - Merocrine/sweat glands in paws can absorb contaminants
 - Extreme temperatures damage paw pads
 - Anatomically, pad nooks and crannies challenging to decontaminate
 - Soft brushes used to scrub paw pads tolerated by most canines
- Contaminated Run-Off
 - Prevent K9 from drinking/licking contaminated run-off
 - Elevation onto table or provide drainage

Human Safety Personal Protective Equipment (PPE)

- Suits
 - Not be more than one level (A, B, C, D) below that of who is being decontaminated
 - One level higher for Ebola
- Eye Protection
 - Tight fitting goggles worn against splash hazards
 - Safety glasses not enough
- Respiratory
 - N-96 protect from spray, mists
 - Safety/HAZMAT determine protection need based on contaminant
- Gloves
 - Nitrile, polyvinyl chloride for protection, durability, tear resistance
 - Double gloving recommended; outer layer heavy glove
- Boots
 - Knee length rubber with slip-resistant soles
- Raised platform
 - K9 decontamination on the ground is back-breaking work
 - Suits may tear depending on surface
 - Alleviates human back/neck injury
 - Promotes better decontamination of the most affected K9 body parts – belly, legs, paw pads

Handler Down

- Ideally and for safety: Handler decontaminates own K9 in the field or accompanies K9 along decontamination corridor
 - Side-by-side Handler & K9 decontamination corridors
 - Handler decontaminates while K9 held in hot zone dedicated kennel; Handler then dons PPE to decon K9 or take them through corridor
- Handler unable/unavailable
 - Performed by another experienced Handler, ideally one known to K9
 - Confine K9 in hot zone dedicated kennel until can be dealt with
 - If contaminant potentially life-threatening, consider PPE protected veterinary/medical directed sedation intervention

DECONTAMINATION MODELS

Decontamination operations must accommodate various needs based on the deployment, the environment, the work, and potential contaminants. Systems range in purpose and design.

- Water – High Volume/Low Pressure
- Water – Low Volume/Low Pressure
- Waterless – Wipe-based Field Decontamination Kits
- Wipes treated and non-treated, wet and dry (antimicrobials, manufactured products)
- Antidotal Products
- Wet-Dry Vacuum System
- Dry Vacuum Decontamination – Extreme Cold Weather

High Volume/Low Pressure Water Decontamination

Advantages

- Expedient for removing a high volume of contaminant that encompasses most or all of the outer canine body
- Method can get deep into the fur to reach contaminated skin
- Can double as a cooling mechanism in hot, humid environment

Disadvantages/Challenges

- Requires large water source
- Collection bladder needed for hazardous waste to avoid contaminating environment and local water aquifers
- Warming water in cold climates to avoid potentiating hypothermia; additional warming tent, meticulous drying recommended as towel drying insufficient in cold weather
- Repeated soap and water applications concerns include superficial dermatitis (insufficient drying), loss of protective dermal oil layer, reduction of normal microbiota
- Repeated decontamination also has potential to increase trans-epidermal water loss and sebum loss, negatively affecting the coat (Discepolo, et. Al)
- Water getting into ears and potential for ear infections
- Not appropriate for field decontamination
- Potential to drive contaminants inward, transferring agents from fur to the skin

Decontamination Corridor System Development – MA TF1 US&R 2007

During MA TF1 annual decontamination drill, search canines were placed in a plastic Kiddie pool and washed down with water from a hose. Several problems were noted:

- The canine and handler were standing in some level of contaminated water, as these pools do not have a water evacuation port
- Team members were kneeling down on the ground for better access to the dog's paws, which tore at the knees, compromising the HAZMAT suit
- Bending over to get the underside and paws of the canine was back-stressful, and may lessen the efficiency of the decon in a more hazardous situation
- One canine started drinking the dirty water in the pool; basket muzzles will not prevent this either, as dogs can lap water through them.

In response, the team wanted to develop a system that addressed these concerns and with the following parameters:

- Elevating the canine
- Inexpensive
- Lightweight
- Durable
- Compact
- Easy and quick to assemble
- Containment of contaminant
- Safe for personnel and canines



MA TF1 Elevation of shelves, non-slip flooring, rope visual barriers, TVI pools



MA TF1 Decontamination Drill circa 2007

Lightweight cost effective easily replaced plastic shelving was built and placed into pools with portholes for water evacuation. The non-slip flooring panels were added when a canine slipped on the wet plastic shelving and another canine's toe got caught in it. They are secured with zip ties. The side ropes were added after a canine decided to jump off the side. They respected the seemingly insubstantial rope and not one of them jumped off after that.

An additional observation at the time was to add on and off ramps to make access onto and exit off of the elevated corridor safer. The ramps would also have a non-slip surface.

Texas A&M University (TAMU)

Photos Courtesy Dr. Deborah Zoran



Canine Decontamination Station with Protection and Containment



Canine Unit with Hose and Drain System



Canine Decontamination Drill

Reserve Corps Decontamination Examples



Washington National Guard
Oso, WA Landslide 2014

Photo Courtesy Lori E. Gordon, DVM



Photo Courtesy SFC Shane Garber

California National Guard 2018



California National Guard California Campfire 2018



Photos Courtesy Deployed Handlers

Low Volume/No to Low Pressure Water Decontamination

Advantages

- Minimal and readily available equipment (bucket, brush, handpump, towels)
- Good for targeted areas on the canine for decontamination
- Simple and quick
- Easily transportable
- Do not need a lot of water
- Intermediate decontamination at a forward Base of Operations (BoO)

Disadvantages/Challenges

- Not for field decontamination
- Repeated washing may cause negative changes and damage to the skin of those targeted areas as well (microbiota, water loss, sebum/oil reduction)



Photos Courtesy Deployed Handlers

Hurricane Sandy 2012

Waterless Field-Based Decontamination Kit

Dr. Brian France (PI, TDA Research), Dr. Mann (CI, VP Veterinary Solutions, Mantel Technologies). et al; US Army Small Business Innovative Research Program and the Army Research Office under Contract No. W911NF-21-C-0024.

Advantages

- Effective method enabling handler to safely remove toxic substances from a working canine in theater/at point of contamination
- Kit is light weight, small, portable, requires minimal equipment
- Physically removes toxicities before affecting canine, handler, and others, decreasing cross-contamination
- Repeated use does not cause dermatitis
- No reactive components
- Oral, dermal, and ocular non-toxic
- Trained and untrained handlers effectively used the kit and achieved similar decontamination results (Note: in study next section trained handlers achieved better decontamination than untrained)

Disadvantages/Challenges

- Single use only; multiple kits required for additional decontamination
- Physical removal only; does not neutralize hazardous substances

Canine Field Decontamination Kit Use Instructions

LIQUID CONTAMINANT REMOVAL

1. **Remove:** Remove contaminated equipment (e.g., collar, vest) and secure the canine during decontamination with uncontaminated equipment, Evacuation Slip Lead is provided in kit.
2. **Dry:** Remove **Wipe A** (dry towel or mitt) from its pouch. Use the dry towel/mitt to absorb liquid contaminants. Pinch the fur/hair at the site of contamination and pull down the length of the hair away from the skin of the canine, see image below. If large areas of the canine are contaminated, use the towel/mitt and lightly rub against the fur's direction of growth to lift the fur and absorb any contaminant. Do not press hard, the goal is to remove the liquid from the fur and prevent transfer to the skin. If skin locations are obviously contaminated, use the dry towel/mitt to absorb as much liquid as possible.

3. **Wet:** Remove **Wipe B** from its pouch. This is a wet towel or mitt with a detergent solution that will be used to remove any residual contaminant from the fur. Repeat the same pinch and pull and/or rub technique from Step 2 as needed; see image right. Do not press hard, the goal is to prevent all liquids including the wet wipe detergent, from reaching the skin.

4. **Dry:** Remove **Wipe C** (dry towel or mitt) from its pouch. Use the dry towel/mitt to absorb any remaining liquid and completely dry the canine. Repeat the same pinch and pull and/or rub technique used in Steps 2 & 3. If areas are obviously wet, use this wipe to fully dry them. Do not press hard, the goal is to prevent all liquids including the wet wipe detergent, from reaching the skin.

5. **Test:** M8 paper can be wiped on the dog's fur and skin to ensure toxic agents have been removed. If a positive is detected, repeat Step 4 to ensure the dog is dry and retest with a new sheet of M8 paper. If the retest is positive, contaminants may remain in the fur, return to Step 3.

6. **Replace:** Once decontaminated, do not put on contaminated equipment. Secon Evaluation Slip Lead is provided. Provide essential medical care and ensure the canine does not re-enter the contaminated area. Continue the mission and seek veterinary medical evaluation as soon as available.

PAPER, CHEMICAL AGENT DETECTOR, VGH, ABC-M8
NSN 8665-00-050-8529
BOOK OF 25 SHEETS

The paper should be used to detect liquid contamination by placing the paper in contact with the suspect surface. A color change similar to that shown on the inside cover indicates the presence of chemical agents.
NOTE: Certain G-agents give a red-brown color response which is intermediate between the typical H&G colors.

DETECTS LIQUIDS ONLY



POWDER OR THICKENED MATERIALS SOLID/POWDER OR STICKY CONTAMINANT REMOVAL

1. **Remove:** Remove contaminated equipment (e.g., collar, vest) and secure the canine during decontamination with clean equipment, field expedient leash or assistance from another person.
2. **Clip:** For thickened or sticky materials that adhere to the canine's fur/hair, use the scissors to remove the outermost 1 cm of fur/hair or more as needed to remove the sticky substance. The scissors have a dull point, but the tips should be angled away from the dog to prevent any injury.

3. **Wet:** Remove **Wipe B** from its pouch. This is a wet towel or mitt that will be used to remove powder/contaminant from the fur. Pinch the fur/hair at the site of contamination and pull down the length of the hair away from the skin of the canine; see image left. If large areas of the canine are contaminated, use the wipe/mitt and lightly rub against the fur's direction of growth to lift the fur. Do not press hard, the goal is to prevent contaminants, including the wet wipe detergent, from reaching the skin.

4. **Dry:** Remove **Wipe C** from its pouch. Use the dry towel/mitt to absorb any remaining liquid and completely dry the canine. Repeat the same pinch and pull and/or rub technique used in Step 3. Do not press hard, the goal is to prevent all liquids including the wet wipe detergent, from reaching the skin.

5. **Test:** M8 paper can be wiped on the dog's fur and skin to ensure toxic agents have been removed. If a positive is detected, repeat Step 4 to ensure the dog is dry and retest with a new sheet of M8 paper. If the retest is positive, contaminants may remain in the fur, return to Step 3.

6. **Replace:** Once decontaminated, do not put on contaminated equipment. Secon Evaluation Slip Lead is provided. Provide essential medical care and ensure the canine does not re-enter the contaminated area. Continue the mission and seek veterinary medical evaluation as soon as available.



Photos Courtesy Drs. Brian France and Kelly Mann
Declassified

Treated Wipes Decontamination

Study Summaries:

A series of scientific studies by co-investigators Perry, E., Discepolo, D., Kelley, R., Jenkins, S., et al. are referenced. Some of their conclusions include the following:

- A simple wipe-down procedure using common veterinary antiseptic cleansers when compared to water revealed dilute povidone-iodine scrub wipes were more effective than dilute chlorhexidine-gluconate scrub wipes or water at removal of aerosolized water-borne particulates from the coat of working dogs
- A simple disinfectant wipe-down procedure using towels saturated with 2% chlorhexidine gluconate scrub or 7.5% povidone-iodine scrub exhibited significant biocidal activity against bacteria present on the exterior coat of working canines, resulting in 99.98 and 98.61% reduction in colony forming units of bacteria; an effective in reducing microbial burden, this may exert selection pressure on resident bacterial flora present on the canine exterior coat
- Canine teams randomly assigned to either trained (30-minutes of interactive training using an illustrated guide on proper utilization of equipment provided) or untrained groups. Trained handlers were more effective at contamination reduction as compared with their untrained counterparts. These results indicate that handlers, when properly trained, can achieve reduction of oil-based contaminants with a disposable decontamination kit and a garden hose.

Pre-Treated and Self-Treated Brushes and Wipes

Advantages

- Simple procedure for targeted effective decontamination
- Improvement with training
- Easily carried
- Inexpensive
- Transportable in small kits to forward BoO, into the field
- Doubles as a treatment for use in wound care

Note on wound care:

- Bactericidal activity: Chlorhexidine diacetate has more bactericidal activity than povidone-iodine and saline, and its effects can last for six hours after irrigation.
- Wound healing: Chlorhexidine diacetate irrigations can be more beneficial for wound healing than saline alone, but wounds treated with chlorhexidine diacetate and povidone-iodine have similar healed areas and contraction.
- Contact time: Povidone-iodine requires a longer contact time than chlorhexidine gluconate, so you may need to adjust your scrubbing time.
- Acute contact dermatitis: Povidone-iodine can cause acute contact dermatitis in dogs more often than chlorhexidine.

Disadvantages/Challenges

- Untrained decontamination personnel may have poorer results
- Repeated use may negatively affect the canine skin if wipe procedures reach that far
- Many have not been tested on canine fur and skin

Treat Wipes and Brushes; OTC Wipes



USED IN VETERINARY CARE

Antidotal Decontamination

Advantages

- Known contaminant with a specific antidotal treatment can be most effectively counteracted
- Military personnel have these kits on hand as per protocol for timely application and use

Disadvantages/Challenges

- Time is of the essence
- Unavailable to the public

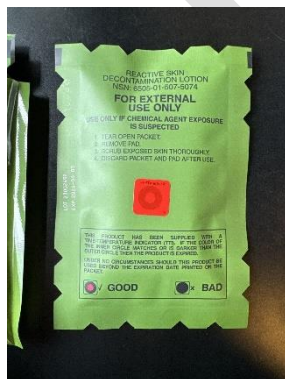
Examples:

- Nerve Agents – Cholinergic
 - Military: wipe M291 Skin Decontamination Kit (SDK) Pads; no eyes, can damage
 - Military – apply Reactive Skin Decontamination Lotion (RSDL)
- Antidote for Lewisite
 - British Anti-Lewisite (BAL) ointment

Pre-Treated Pads and Wipes



UNTESTED ON CANINE FUR/SKIN



Bing Stock Images

Wet-Dry Vacuum Systems

This is a self-contained wet-dry vacuum system. The larger unit has a heater. It uses Accelerated Hydrogen Peroxide solution: 0.1% dilution kills mycobacteria and viruses; converts to water vapor and oxygen when dry; <2 liters water per K9

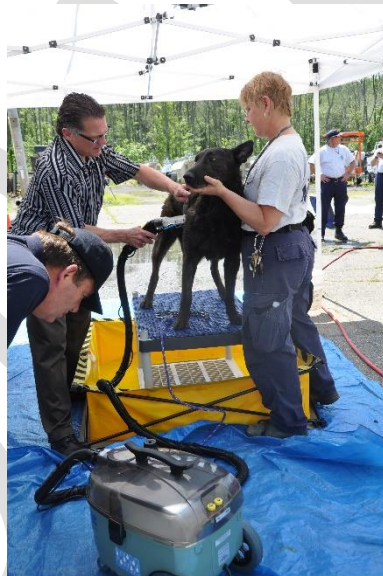
- Gets beyond hair coat to reach skin

Advantages

- Antimicrobial and antiviral properties
- Gets beyond hair coat to reach and decontaminate the skin
- Easy to train on its use
- H₂O₂ solution converts to non-toxic water vapor and oxygen after use
- Requires less than 2 liters of water to decontaminate entire canine
- Portable unit

Disadvantages/Challenges

- Cost
- Requires a plug-in energy source



Photos Courtesy Lori E. Gordon, DVM

Dry Vacuum Decontamination

Advantages

- Usable system in extreme cold weather
- Suctions contaminants way from skin and fur
- Decreases aerosolization of powders

Disadvantages/Challenges

- Challenges extracting liquids/caked on substances not yet investigated
- Cost of vacuuming unit as yet undetermined
- Training required
- Decontamination requires contained space, heated



Arctic Eagle 2020 After Action Report
Declassified

Extreme Cold Weather Conditions

Arctic Eagle Exercises

- Unclassified Joint, Interagency, Intergovernmental, and Multinational (JIIM) biennial cold-weather exercise organized by the Alaska National Guard
- Overall mission to train and test equipment in arctic environments while demonstrating interoperability with other agencies in emergency response

Arctic Eagle (AE) Dry Decontamination

- Objective: develop workable Tactics, Techniques, and Procedures (TTPs) for working in Extreme Cold Weather (ECW) and document for future use
- Tested use of Nikko Dry DECON System for Search K9s (Vacuum System)
- Developed by the Chemical Biological Incident Response Force (CBIRF) based out of Naval Support Facility at Indian Head, Md.
- Flour used to simulate particulate contamination

AE 2020 Dry Decontamination Results

- Effectiveness
 - Vacuuming $\geq 80\%$ effective 'contaminant' removal per visual assessment from K9 coat, undercoat, face, and paws
- Issues
 - Handler difficulty restraining and vacuuming K9 simultaneously
 - Non-compliant K9s minimally decontaminated
 - Vacuum passed between hands, becoming contaminated
 - Areas of concern not prioritized (belly, legs, paws, face)
- Recommendations
 - Additional Handler, DVM, in Decon to assist with K9 handling
 - Handler restrains while technician decontaminates
 - Wiping of vacuum handle when passing between personnel
 - Systematic K9 anatomical vacuuming protocol



AE 2022 Dry Decontamination

- Improvements from 2020
 - Decontamination Lanes parallel with human decontamination lanes
 - Longer elevated lane for gross and technical decontamination
 - Stepping stool to facilitate canines jump onto table
 - Handler self-gross decontaminates; stays with and holds canine
 - Muzzling required
 - HAZMAT Technician performs decontaminations
 - Gross- Fibertect™ dry pad
 - Technical – Nikko Dry Decon System
- Effectiveness
 - No powder simulant was approved in time for exercise
 - Concentrated on technique and identifying operational issues
- Issues
 - Step stool challenging
 - Sound and unfamiliar personnel and equipment initially caused canines to shy away if initial approach was at their head/face
 - Technicians pulled limbs to the side
- Recommendations
 - Ramp better for canine getting onto and off of elevated tables
 - Begin vacuum at shoulder area, allowing for time to acclimatize, then proceed to face, neck, back, and down limbs
 - Just in Time (JIT) training of technicians regarding handling or canine limbs: lift paw and angle back in line with their body (flexion of forelimb carpus/wrist, flexion of hindlimb tarsus/ankle)



Artic Eagle Exercise
2022



Photos Courtesy
Lori E. Gordon, DVM

DECONTAMINATION TRAINING MODEL STUDIES

In a study by Erin Perry, et. al they assessed where contamination most often occurs, using an oil-based UV fluorescent marker pooled to mimic standing liquid hazards in a simulated disaster scene to characterize anatomical locations likely to be contaminated.

- Contamination occurred consistently on the paws and lower legs with overall ventral exposure occurring in 39 of 44 (89%) observations.
- Contamination of the back and head was infrequent, with overall dorsal exposure occurring in 11 of 44 (25%) observations.
- Despite handler awareness of the exact anatomical locations of exposure with a greater frequency of exposure involving ventral (78%) versus dorsal (22%) regions of the canine ($P < 0.0001$), time spent decontaminating the two regions did not differ ($P = 0.881$).
- This suggest decontamination method training may be advantageous in achieving better results for removing contaminants

Decontamination drills have revealed several ways to improve decontamination:

- If possible, elevating the canine improves one's access to and ability to remove contaminant from the most commonly affected areas – the ventral (underneath) areas of the canine body, especially paws, limbs, ventral neck and abdomen
- Elevation also decreases human back injury from constant bending over
- Wiping from top to bottom and front to back in a consistent manner assure all areas are attended to, unless targeted areas are obvious and require more immediate attention
- Some canines may be initially wary of the process, so starting at the shoulder rather than at their face/head gives time to adjust to the object, odor, and process so as to avoid any initial backing-away



Dr. Erin Perry Researching inside and in the field

Photos Courtesy
Lori E. Gordon, DVM

CANINE RESPONSE TO CBRNE

There are similarities and differences in the effects of and the response to exposure of canines to chemicals, biologics, radiation, and explosives. This section will evaluate canine resistance, susceptibility, their signs and symptoms, decontamination (external and internal) recommendations, and treatments/antidotes if known.

Signs, Symptoms detectable in canines that are the same as in humans

- Eyes
 - Tearing
 - Conjunctivitis
 - Pupils pinpoint, dilated
- Mucous Membranes
 - Pale
 - Bright red
- Respiratory
 - Cough
 - Choke, gag
 - Gasping, labored
- Gastrointestinal
 - Salivation (nausea)
 - Vomiting
 - Diarrhea
 - Abdominal cramping
- Mentation
 - Malaise, dullness
 - Disorientation
- Neurologic
 - Twitching
 - Seizures
 - Paralysis

Signs and Symptoms in the canine difficult to detect, confirm, and/or recognize

- Headache
- Tightness in chest
- Sweating
 - Canines cannot sweat from their body
 - Their only sweat glands are located in their paw pads
- Skin Rash
 - Hidden by fur in most areas
 - Visible in the axilla, flank/upper inner thighs, inner ear pinna/flap
- Small Wounds
 - These also may be hidden by fur
 - Flinching when touched or if your hand comes away with blood
 - Pad wounds may leave bloody prints
 - Canine will often lick incessantly at a wound (saliva has antimicrobial as well as cleaning properties)



Dogs of War

CHEMICAL, BIOLOGICAL, RADIOLOGICAL CANINE EXPOSURE REVIEW DECON SECTIONS

Nerve Agents – Cholinergic

Most toxic of warfare agents, rapid onset of action, gaining access to the body via multiple routes of entry. They include Tabun (GA), Sarin (GB), Soman (GD, GF), V-agent/Venom X (VX)

- Physiology
 - Inhibit acetylcholinesterase, the enzyme that neutralizes the neurotransmitter acetylcholine at nerve-muscle or nerve-gland junction
 - Affects the Peripheral Nervous System where ACh acts on 2 different receptors:
 - Nicotinic - neuromuscular junction of skeletal muscles, post-ganglionic neurons of parasympathetic NS, some brain neurons
 - Muscarinic - neuromuscular junction of cardiac & smooth muscle, glands, post-ganglionic neurons of sympathetic NS
 - "SLUDGE" and "DUMB BELS" symptoms
 - Affects the Central Nervous System as well
- Canine Sensitivity (w/r to humans)
 - Tabun (GA): ¼ sensitive inhalation form, ½ sensitive to dermal form
 - Sarin (GB): ¼ sensitive inhalation form; twice as sensitive dermal form
 - Venom X (VX): about same sensitivity to inhalation and dermal forms
- Prevention
 - Protective sheltering
 - Chemical impervious paw barrier: butyl-rubber gloves, polyethylene bags, MRE outer bag
 - Skin Exposure Reduction Paste against Chemical Warfare Agents (SERPACWA) on non-haired areas (inner ear/pinna, axilla/armpit, flank/groin)
 - Prophylaxis with Soman Nerve Agent Pyridostigmine Pretreatment (SNAPP) not documented in canine; toxicity mimics nerve agent exposure
- Symptoms
 - Early Effects are mainly muscarinic signs: miosis, involuntary urination, defecation, hyperpnea, bradycardia, excessive lacrimation, hypersalivation, dyspnea (bronchoconstriction), tachycardia (catecholamine release)
 - Late Effects are nicotinic and CNS: nausea, vomiting, generalized weak, drowsy, ataxia, seizures, cyanosis, respiratory arrest, muscle fasciculations, confusion, anxiety, hyperthermia, flaccid paralysis, collapse, unconscious, coma, death
- Decontamination
 - Military: wipe M291 Skin Decontamination Kit (SDK) Pads; no eyes, can damage
 - Military – apply Reactive Skin Decontamination Lotion (RSDL)
 - Flush dermal wounds with copious amounts of soap and water
 - Flush eyes – saline, water
 - Technical decon 0.5% Na hypochlorite (1:10 bleach) 2-5 minutes, then rinse well

- Antidotes
 - Nerve Agent Antidote Kit (Mark 1) – 1 to 2 auto-injections of 2-PAM Cl and 2-3 auto-injections of Atropine
 - Antidote treatment Nerve Agent Auto-injector (ATNAA) – 1-2 injections
 - Convulsant Antidote for Nerve Agent (CANA) – 1 auto-injection; repeat if still seizing

Specific individual drug dosing

1. *Atropine sulfate* @ 0.2-2.0 mg/kg: give ¼ dose IV, rest IM or SC; repeat, if necessary, based on the reappearance or persistence of respiratory signs (not based on salivation or miosis); drug effects last 4-6 hours...avoid overdose!
 2. *Pralidoxime chloride* (2-Pam) @ 20-50 mg/kg IV SLOWLY or SC every 12 hours. Start with low dose; if no response after 3-4 doses, then discontinue
 3. *Diphenhydramine* 1-4 mg/kg IM or PO every 8 hours to relieve muscle tremors. Start with lower dose if giving IM
 4. *Diazepam* @ 5-10 mg IV; poorly absorbed IM, injection is painful. Midazolam same dose better for IM administration w/r to absorption and less painful
- Treatments
 - Induce emesis only if ingestion was within last 60 minutes and patient shows no clinical signs (Clevor)
 - Perform gastric lavage if possible; alternatively administer activated charcoal (activated charcoal may be indicated for dermal exposure due to absorption)
 - Clear airway of fluid, provide oxygen
 - Secure airway if needed, ventilate, 80-100% oxygen for at least 30 minutes
 - Vitals monitoring – ECG, BP, PO, CO₂
 - Treat hyperthermia
 - Supportive care

🎵 NOTE

Nerve agent VX was used in the development of the waterless Canine Field Decontamination Kit innovated by Dr. Brian France (PI, TDA Research), Dr. Mann (CI, VP Veterinary Solutions, Mantel Technologies), Robert Buntz and Richard Vargus (Animal Decontamination Working Group) under the US Army Small Business Innovative Research Program and the Army Research Office under Contract No. W911NF-21-C-0024.

Additions of these innovations are planned for incorporation future Standard Operating Procedures (SOPs) once further work is completed in refining training, product availability, further drills, and impact on triage, decontamination procedures, and other contaminants.

Blister Agents - Vesicants

Irritation and wounds are caused by direct contact with liquid or with high vapor concentrations. The eyes and warm, moist, thin-skinned areas (abdomen, axilla, flank) and respiratory tract are most sensitive. Open sores are susceptible to infection and take a long time to heal. These include Mustard Agents (H, HD, HN-1, HN-2, HN-3), Phosgene Oxime (CX), and Lewisite (L) which is an arsenical compound

- Physiology
 - Blister agent damage mechanisms of skin and cornea not understood.
 - Exposure times and agent concentration affect severity of damage
 - Respiratory tract exposure leads to severe mucosal tissue irritation, causing fluid secretion. This disrupts oxygen transfer within the pulmonary alveoli. Victims may also be susceptible to pneumonia.
- Sensitivity (w/r to humans)
 - HD: $\frac{2}{3}$ as sensitive to inhalation form; $\frac{1}{4}$ as sensitive to dermal form
- Prevention
 - Chemical impervious barriers on paws – butyl-rubber gloves, polyethylene bags, MRE outer bag
 - Skin Exposure Reduction Paste against Chemical Warfare Agents (SERPACWA) on non-haired areas (inner ear/pinna, axilla/armpit, flank/groin)
- Symptoms
 - Mustards* – delayed symptoms
 - Eyes: corneal/conjunctiva irritation, tearing, light sensitive, blind
 - Skin: red moist skin, swelling within 2-3 hours, piloerection
 - Respiratory: nasal discharge, dry cough, hoarse bark, nausea, vomiting, fever, dyspnea, hemoptysis
 - Lewisite, Phosgene* – acute symptoms
 - Eyes: tearing, painful swollen lids, corneal scarring, iritis, blindness within 1 minute
 - Skin: red within 30 minutes, pain, itching, deep burns
 - Respiratory: profuse nasal secretions, violent sneezing, cough, frothy mucous, pulmonary edema
 - Systemic: restless, weak, hypothermia, low blood pressure

♪ NOTE: Canine dermal blood supply and skin reaction to chemicals differs w/r to human skin in that they do not develop blisters. Rather their skin becomes moist and hyperemic (reddens). Depending on the extent of the damage, skin may slough away, leaving open wounds. Because of their furry coat, meticulous physical examination of canine skin is needed to detect chemical burns early. Flinching or painful reaction when touched may be the only sign. Areas may be moist from fluid leak. More noticeable skin damage may not become apparent for hours to days.

- Decontamination
 - Military – wipe with M291 Skin Decontamination Kit (SDK) Pads (not around eyes, can damage)
 - Flush dermal wounds with copious amounts alkaline soap and water

- Flush eyes copiously– saline, water
- Technical decontamination with 0.5% sodium hypochlorite (1:10 bleach) 2-5 minutes, then rinse well
- Antidote for Lewisite
 - *British Anti-Lewisite (BAL) ointment*
 - *British Anti-Lewisite (BAL) Injectable* is also known as dimercaprol (used to treat arsenic and lead poisoning) @ 2.5-5.0 (up to 7 mg/kg for severe cases) mg/kg IM every 4 hours for 2 days, then every 12 hours for the next 10 days
 - *Edetate calcium disodium (CaEDTA)*, a heavy metal chelator, may be used if BAL not immediately available; 1% solution (10 mg/ml) in NS or D5W @ 27.5 mg/kg SC q 6 hours for 5 days, wait 5 days, repeat if needed
- Treatments
 - Alkaline solutions (Na bicarbonate, Ca carbonate) will hydrolyze CX
 - Antibiotics (cefazolin/Keflex, ciprofloxacin/Baytril)
 - Analgesics (narcotics, NSAIDs)
 - Fluorescein cornea, treat as indicated
 - Wound treatments – clip hair, topical antibiotic, silver sulfadiazine, protective bandages (wet-to-dry or non-adherent)
 - Anti-emetics if vomiting (chlorpromazine, ondansetron (Zofran), dolasetron (Anzemet), maropitant citrate (Cerenia)
 - Clear airway of fluid, provide oxygen
 - Secure airway, ventilate, 80-100% oxygen for at least 30 minutes
 - IV access for cardiovascular and respiratory support
 - Monitoring, blood collection and monitor electrolytes, acid-base

♪ NOTE

Nerve agent VX was used in the development of the waterless Canine Field Decontamination Kit innovated by Dr. Brian France (PI, TDA Research), Dr. Mann (CI, VP Veterinary Solutions, Mantel Technologies), Robert Buntz and Richard Vargus (Animal Decontamination Working Group) under the US Army Small Business Innovative Research Program and the Army Research Office under Contract No. W911NF-21-C-0024.

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Choking/Pulmonary Agents; Incendiary Agents, Irritant Gases

Choking Agents are gases or volatile liquids that dissipate rapidly. Their main effects are to the respiratory system via inhalation. Skin contact with concentrated material may cause chemical burns, but is not absorbed. These include Chlorine (CL), Phosgene (CG), Diphosgene (DP), Chloropicrin (PS), and Ammonia.

Incendiary Agents cause deep burns, these include White Phosphorous (WP)

Irritant gases (riot agents) have little effect on canines. These include bromobenzyl cyanide (CA), chloroacetophenone (CN), O-chlorobenzylidene malononitrile (OC)

- Physiology
 - *Choking agents* are irritating to the respiratory tract. Irritation from contact with respiratory tract mucosa causes fluid secretion. If the lung parenchyma is affected, alveolar sacs fill with fluid (pulmonary edema) and oxygen transfer from lungs to bloodstream is compromised. This is sometimes referred to as 'dry land drowning'.
 - *Incendiary agent White Phosphorous* smoke is generally not toxic. It burns spontaneously when exposed to air; oxygen must be eliminated to stop the burning.
 - *Riot Agents* harshest effect is if they contact the eyes, causing severe irritation.
- Sensitivity with respect to humans
 - CN, CS, OC: quite insensitive to these (riot control agents)
- Prevention
 - Respiratory protection, unavailable to working search canines, is the best protection against inhalation
 - Eye protection goggles
 - Locating upwind
- Symptoms
 - *Chlorine, Phosgene, Ammonia*: Coughing, choking, lacrimation (tearing), foamy saliva, nausea, vomiting, dizziness, syncope, faint, skin irritation, hypoxia, cyanosis, burning eyes, nose, mouth, throat, lower respiratory tract
 - *White Phosphorous*: Particles cause severe burns on contact; smoke not as harmful.
 - *Riot Agents*: Severe eye irritation
- Decontamination
 - Move animal from contaminated area immediately; fresh air
 - Flush eyes, nose, mouth with water/saline, ophthalmic if available
 - Flush wounds with copious amounts of water
 - *White Phosphorus* – eliminate exposure to oxygen by submerging area in water or covering affected area with water-soaked dressing
 - *White Phosphorus* – bathe in bicarbonate solution, neutralizes phosphoric acid which becomes visible for removal as luminescent spots in the dark

- Irritant gases (Riot Agents) -0.25% Sodium Sulfite more effective than saline/water to dissolve and neutralize irritant
- Treatments
 - Rest, minimal activity; extreme exertion is dangerous especially if respiratory signs (pulmonary edema)
 - Fluorescein cornea for damage; ophthalmic antibiotic ointment (no ulcer- steroid)
 - Flush wounds with copious amounts of water, treat based on severity (clip hair, antibacterial ointment/silver sulfadiazine, bandaging wet-to-dry or non-adherent)
 - *White phosphorous* – local ophthalmic anesthetic to remove all particles adhered to cornea before staining and topical treatments (Abs, atropine)
 - *White Phosphorous* - burn wound debridement ASAP so particles do not remain to be absorbed later
 - Antibiotics (cefazolin/Keflex, ciprofloxacin/Baytril)
 - Analgesics (narcotics, NSAIDs)
 - Consider anti-emetics if vomiting (chlorpromazine, ondansetron (Zofran), dolasetron (Anzemet), maropitant citrate (Cerenia)
 - Clear airway of fluid, provide oxygen
 - Secure airway, ventilate, if necessary, 80-100% O₂ at least 30 minutes
 - IV access for cardiovascular and respiratory support
 - Monitoring, blood collection and monitor electrolytes, acid-base
 - Bronchodilator (terbutaline, albuterol, aminophylline, metaproterenol)
 - Diuretic therapy (furosemide, mannitol)? Non-cardiogenic pulmonary edema from damaged alveolar-pulmonary membranes



Dogs of War

Blood Agents - Asphyxiants

These agents interfere with oxygen transport and/or utilization by displacing oxygen from ambient atmosphere, decreasing oxygen available to the lungs.

They include Carbon Monoxide (CO), Hydrogen Cyanide (AC), Cyanogen Chloride (CK), Hydrogen sulfide, and Halogens

- Physiology
 - Carbon Monoxide – affinity for hemoglobin is 240 times that of oxygen, replacing O₂ on heme portion of red blood cell to form carboxyhemoglobin
 - Hydrogen Cyanide – inactivates cytochrome oxidase system by irreversibly combining to ferric ion of cytochrome oxidase; blood becomes oxygenated but cells blocked from using it, turn to anaerobic metabolism
 - Hydrogen Sulfide – binds to mitochondrial cytochrome oxidase, blocking electron transport and causing cellular asphyxia
 - Halogens – chlorine generates to hydrochloric acid and oxygen free radicals; bromine causes direct injury effect to mucous membranes; fluorine causes cardiac toxicity and asphyxiation by saturating room air (as chlorofluorocarbon).
- Prevention
 - Respiratory protection, unavailable to working search canines, is the best protection against inhalation
 - Locating upwind
 - Sheltering
- Symptoms
 - Carbon Monoxide and Hydrogen Cyanide
Bright red mucous membranes, cherry red blood, tachypnea, dyspnea, hyperpnea, confusion, ataxia, lethargy, seizure, coma, death
 - Hydrogen Sulfide and Halogens
Salivation, blepharospasm, tachypnea, pulmonary edema, pneumonitis, confusion, dizziness, nausea, vomiting, seizure, coma, respiratory arrest
- Decontamination
 - Decontamination is via treatment regimen: oxygen therapy, positive pressure ventilation, and antidote medications
- Antidotes
 - Carbon Monoxide – Oxyglobin, fresh blood transfusion, hyperbaric oxygen
 - Hydrogen Cyanide – Na thiosulfate, Na nitrite if diagnosis certain, Oxyglobin; emesis if ingested ≤ 15 min, gastric lavage if 15-60 min; activated charcoal
 - Hydrogen sulfide – Sodium nitrite
 - Halogens: copious irrigation of eyes and skin, corticosteroids, antibiotics; Fluorine - avoid adrenergic drugs (avoid cardiac stimulation)

- Treatments
 - Move affected animal to fresh air immediately
 - Secure airway; ventilate, if necessary, 80-100% oxygen at least 30 minutes
 - IV access for cardiovascular and respiratory support
 - Monitoring, blood collection and monitor electrolytes, acid-base
 - Bronchodilator and diuretic therapy as needed
 - Seizure control. Monitor temperature

Incapacitating Agents - Anticholinergics

Anticholinergic agents are similar pharmacologically to the drug atropine. It includes 3-quinuclidinyl benzylate (BZ)

- Physiology
 - Competitively antagonize the neurotransmitter acetylcholine (ACh) at postganglionic parasympathetic (cholinergic) nerve fibers
 - Targets smooth muscles influenced by acetylcholine but lack innervation
 - Affects glandular secretions, intestinal motility, bronchi, cardiac rate/function
- Prevention
 - Protective sheltering
 - Chemical impervious barriers on paws – butyl-rubber gloves, polyethylene bags, MRE outer bag
 - Skin Exposure Reduction Paste against Chemical Warfare Agents (SERPACWA) on non-haired areas (inner ear/pinna, axilla/armpit, flank/groin)
- Symptoms
 - Tachycardia, hyperthermia, dry skin, dry mucous membranes, mydriasis (dilated pupil), blurred vision, odd behavior, stupor, confusion, incoordination
 - "Hot as a hare, red as a beet, dry as a bone, blind as a bat, mad as a hatter" or "Can't see, can't spit, can't pee, can't poop"
 - The 'anti-sludge': lack of salivation, lacrimation, urination, defecation, GI stress/diarrhea, emesis
- Decontamination
 - Warm soapy water
- Antidotes
 - *Physostigmine* @ 0.06 mg/kg IM or IV over 5 minutes
 - *Pyridostigmine* @ 0.1 mg/kg (IV, IM?) or 0.5-3.0 mg/kg PO q8-12 hours
 - *Neostigmine* @ 0.02-2.0 mg/kg IM PRN or 0.5 mg/kg PO q8-12 h
- Treatments
 - Restrict activity
 - Monitor hydration; promote water intake; rehydrate SC, IV
 - Antidotes
 - Supportive care
 - * Anesthetics, sedatives, tranquilizers contraindicated; potentiate BZ effects

BIOLOGICAL AGENTS

Although canines are unlikely targets for biological terrorism (animals in our food supply chain may be targeted) they may act as carriers. Therefore, purposeful exposure to a biological agent is of less concern, but a concern nonetheless. Among the 300 or so possible human pathogens that could be used for terrorist purposes, only a few have been investigated due to characteristics that make them ideal for military use. These fall in bacteria, rickettsia, virus, and toxin categories.

- **Bacteria**
 - Anthrax (*Bacillus anthracis*) **canines are 500-1000 times more resistant**
 - *Ingestion may cause disease; prophylaxis, decon to decrease human exposure
 - Typhoid (*Salmonella typhus*) **canines are naturally resistant**
 - Brucellosis (*B. abortus*, *B. melitensis*, *B. suis*) **canines transmit to human**
 - Plague (*Yersinia pestis*) **intermediate host for flea transmission**
 - Tularemia (*Francisella tularensi*)
 - **Rickettsia**
 - Q Fever (*Coxiella burnetti*)
 - **Virus**
 - Venezuelan Equine Virus (*VEE* virus)
 - Smallpox (*Variola virus*) **canines are naturally resistant**
 - **Toxins**
 - Botulinum (Botulinum toxins)
 - Ricin (from castor beans)
 - Staphylococcal Enterotoxin B (*Staph aureus*)
- } canines susceptible
but less sensitive
- } canines susceptible
but less sensitive

Anthrax Note

Canines are resistant, however dermal contamination may expose humans. Decontamination consists of soap and water. 0.5% hypochlorite solution can be used on equipment.



Dogs of War

RADIOLOGICAL AGENTS

Two radiation concerns are *exposure* and *contamination* by radioactive material:

- **Exposure** occurs by external irradiation, when all or parts of the body are exposed to penetrating radiation from an external source. This is primarily an *external* exposure, but may become *internal* through wounds or broken skin.
- **Contamination** occurs when the radioactive materials in the form of gases, liquids, or solids are released into the environment. This can result in both *external* and *internal* contamination. The concern with terrorism is the use of a Radiological Dispersal Device (RDD) or 'dirty bomb' to effect contamination.

Ionizing radiation may be less likely for a terrorist to obtain, but the possibility does exist and nuclear energy accidents are also of concern (Fukushima Daiichi Nuclear Power Plant, Japan, 03/2011). In addition, medical and industrial facilities are possible sources of radiologic contaminants. These sources could be in any community that we respond to that has been hit by a flood, mudslide or any other type of event.

Brief radiation emission review:

☠️ Alpha particles

- ☞ Limited penetration: stopped by superficial dead skin layer, sheet of paper
- ☞ Ingestion is very dangerous
- ☞ Presence may be masked by water

☠️ Beta Particles

- ☞ More penetration but generally travels just a few inches in the air
- ☞ Stopped by inner skin layers but also dangerous if ingested

☠️ Gamma Radiation

- ☞ Not particulate, more like a high-energy x-ray with long range
- ☞ Significant penetration; dangerous whether external or ingested

☠️ Neutrons

- ☞ Most immediately damaging to cells on contact, travel far in air
- ☞ Stopped by water, paraffin, or plastic

Canines may be from 25%-70% more sensitive than humans to the acute effects of the same radiation exposure. The range is due to different effects on varied body systems (skin, GIT, RBCs, WBCs, etc...) Effects are usually delayed, and specific signs and symptoms depend on many factors related to the exposure and to the victim. Treatments are similar for both species.

TIME, DISTANCE, and SHIELDING still the best option in a radiation hazard event!

SOAP and WATER DECONTAMINATION

- Baby Shampoo (like Johnson's®, perfume free) recommended for 2 reasons:
 1. Fewer fragrances than other shampoos - decreases skin reactions
 2. Contains *Trisodium EDTA*, a chelator of heavy metal ions, including various radioisotopes, removing these from hair follicles if used within 45 minutes of radioactive fallout.
 3. Targeted decontamination based on radioactive screening may decrease negative side effects of water and soap on the canine skin

Illicit Opioid Drug Exposure

- Accidental inhalation or ingestion during search
- Includes: morphine, codeine, heroin, oxycodone, hydrocodone, hydromorphone, meperidine, fentanyl, methadone
- Internal Decontamination
 - Naloxone (Narcan®) nasal spray, injection
 - Naloxone (Evzio®) auto-injector
 - Starting dose 0.04 mg/kg IN, *IM*, IV; repeat as needed
- External Decontamination
 - Damp wipes to remove particulate drug (granules, powder, dust)
 - Soap and water (whole body or target exposed areas)

Petroleum-Based Heavy Contamination

July 2007 the Massachusetts Task Force 1 conducted a canine decontamination drill to test their ability to remove a petroleum-based contaminant from the search canines. The contamination test product was Glo-Germ®, a non-toxic product not visible in regular light but shines bright orange under a black light.

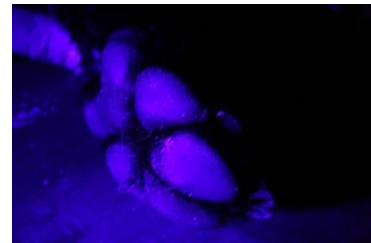
- The handler and two other team members were placed in a level B suit to give them the experience of having to don this level of personal protection, as well as get the dogs used to interacting with people in a suit.
- After paw contamination was confirmed using black light, soap and water decontamination was performed. Paws rechecked under black light illumination still had test product contamination.
- It was then suggested that since the contaminant was oil based, perhaps dissolving it in some mineral oil would help break it up before applying the detergent. The theory is that ***like dissolves like***. A small amount of mineral was used at the beginning of the decontamination corridor. When the paws were checked under the black light for level of decontamination, no grossly visible evidence remained of the Glo-Germ®.



Confirmed Contamination



Soap & Water Only



Mineral Oil Pre-Treatment

Conclusion: ***for an oil-based contaminant, pre-treatment with mineral oil may significantly increase the efficiency of the decontamination.***

REAL WORLD TOXIN EXPOSURES DECONTAMINATION OPERATIONS

World Trade Center, New York, USA, September 2001

K9 Decontamination Stations:

Hurricanes, Fires, Landslide, Tornado

Tornado in Joplin, Missouri, USA, May 2011

Documented Toxin Exposures – WTC 2001

Environmental toxins detected in serum of dogs in prolonged and brief exposure groups

- Quinoline
 - 3-methyl quinoline
 - Isoquinoline
 - Diphenylamine
 - Surfynol
 - 2-(1-phenylethyl) phenol
 - Mean blood [lead] significantly higher
 - Mean serum [iron] not significantly different
- } known
} carcinogenic
} mutagenic



World Trade Center 2001



World Trade Center 2001

Toxin Absorption Exposure

Tornado, Joplin, Missouri, May 2011

- Day 2 Home Depot search where products damaged; powder and liquid spills noted
- K9s worked 5-8 hours; no decon until after shift
- Within 24 hours 3 of 5 K9s displayed
 - Hypersalivation
 - Polydipsia
 - Diarrhea
 - Respiratory distress
- Within 48 hours
 - 1 K9 developed jaundice (liver failure)
 - 1 K9 developed kidney failure



Joplin, MO Tornado 2011 Home Depot

Photos Courtesy MA TF1

Photo Courtesy NE TF1

REAL WORLD CANINE DECONTAMINATION STATIONS

TERRORIST EVENT DISASTER

World trade Center, New York, NY, USA; September 2001

- HAZMATs: industrial chemicals, airplane fuel, human remains
- VMAT, SPCA, LIVMA, FDNY



Photos Courtesy MA TF-1

World Trade Center 2001



World Trade Center 2001
Photos Courtesy VMAT-1

FIRE

Gloucester, Massachusetts, USA; December 2007

- HAZMAT: human remains, asbestos
- Weather cold: heated water, warming tent
- Massachusetts Task Force 1 US&R decontamination tent



Photos Courtesy MA TF1

FIRE

California, USA Camp Fire; November 2018

- HAZMATs: human remains, narcotics, chemicals, anti-freeze
- National Guard decontamination operations



Photo Courtesy M Matthews



Photo Courtesy Eric Darling

Photos Courtesy CA National Guard and SFC Shane Garber

HURRICANES

Hurricane Katrina, New Orleans, Louisiana, USA; August 2005

- HAZMATs: standing water, human remains, household chemicals
- TFs, Local Fire Fighters provided K9 decontamination



Photos Courtesy MA TF1

Hurricane Maria, Puerto Rico; September 2017

- HAZMATs: standing water, Leptospirosis
- Task Forces improvised K9 decontamination



Photos Courtesy Lori E. Gordon, DVM

Hurricane Michael, Mexico Beach, Florida, USA; October 2018

- HAZMATs: flood waters, HR, lead, asbestos, pesticides, petroleum
- FEMA US&R Task Forces provided own K9 decontamination



Photos Courtesy Lori E. Gordon, DVM

Photos Courtesy Lori E. Gordon, DVM

TORNADO

Joplin, Missouri, USA; May 2011

- HAZMATs: industrial chemicals, pesticides, human remains, standing water
- Local Fire Fighters and TF Handlers provided K9 decontamination



Photos Courtesy NE TF1

LANDSLIDE

Oso, Washington, USA; April 2014

- HAZMATs: human remains, household chemicals, standing water
- Washington State National Guard provided decon ops



Photos Courtesy Lori E. Gordon, DVM

CANINE DECONTAMINATION KITS – Water Based

A. Equipment – General

1. Boxes/containers for equipment and supplies
2. Waterproof tarp
 - 1-2 laid on the ground, decontamination set-ups are placed on top.
3. Sealable industrial strength plastic bags
 - Collect and contain contaminated items
4. Hose
5. Spray nozzle or wand
 - Allows for water to be better directed underneath the canine (belly wash)
 - An adjustable water flow
6. Buckets
 - Used to throw in the contaminated collars, leashes, and used brushes until they can be collected in bags for disposal
 - Also, can be used to decontaminate metal items that will be reused
 - Can be used alone for low water/low to no pressure targeted decontamination set up
7. Water heater (separately stored item)
 - To prevent hypothermia in a cold weather deployment
 - A tent or other environment that can be warmed and provides wind protection is needed as after water decontamination while canines dry off
 - If not available, consider a groomer drying unit to quickly dry the canine
8. Pools – 2 (separately stored item)
 - A CBRNE or HAZMAT decontamination model uses two separate areas: one for wash station and another for the rinse station
 - One that has a hose connection to divert contaminated water away, are easily set up and fold down to a small unit for storage
9. Elevated Shelving
 - Advantages include keeping the canine out of contaminated water, preventing them from drinking that water, easier to decontamination properly (especially under the belly and the paws), easier on your back, and easy to assemble
 - Rubberized decking if shelving is slippery when wet
 - Inexpensive, light-weight, and easily assembled
10. Ramps for access onto and off of elevated decontamination shelving/tables; non-slip
11. Shallow Pan or Box
 - If a biologic hazard is suspected, walk the canine through a foot bath of dilute Clorox solution (0.5% sodium hypochlorite made by 1:10 dilution in water) or other antimicrobial solution as deemed appropriate for the hazard



Photo Courtesy Dr. Gordon

B. Equipment – Human PPE

1. Eye protection
 - 4-8 pairs of goggles if needed to protect from contaminated water spray
 - The canines will inevitably shake themselves at some point as well

2. Gloves – 2 boxes
 - Latex or all non-latex to cover latex allergies, these often tear with much use
 - A heavier over-glove if needed for protection from more hazardous materials
3. Masks
 - Situation-appropriate issue
4. Tyvek Suits or situation-appropriate issue protective suit

C. Decontamination Supplies

1. Mineral Oil in spray bottles
 - Easier application to areas of thick petroleum-based contamination (usually on the paws and in between the toes)
 - The adage 'like dissolves like' is the basis for using this oil to break up the contaminant, then applying a shampoo or soap to remove it from paws or hair
2. Ophthalmic (Eye) Rinse
 - This is used if there are clear signs of eye irritation or contamination, otherwise it is left for the post-decontamination medical check to use if needed
 - There are over-the-counter saline and purified water solutions
 - Aid in flushing out a foreign body
3. Liquid soaps
 - Dish detergents (Dawn® or Palmolive®) traditionally used in animal decontamination; diluted 50:50 to decrease rinsing challenges
 - Baby shampoo (Johnsons® perfume-free) for radiation chelation
 - Joy® or Prell® products less sudsy alternative. These work just as well with a thorough scrub
4. Dog shampoo/conditioner
 - This will help re-establish the coat after several soap shampoos
 - Decreasing times water decontamination is performed, using another less aqueous method even better
5. Surgical scrub brushes
 - Not harsh yet stiff enough to work; we found surgical scrub brushes work well especially to get into the nooks and crannies of paw pads
 - The BD E-Z Scrub 160 Ref 1603 have a plastic bristle side and a sponge side; come as plain or infused with chlorhexidine
6. Absorbent material
 - Baking soda or cornstarch are typically used to absorb a liquid contaminant and then be wiped off/pinched off
 - Other: diatomaceous earth, Fuller's earth, soil, activated charcoal, synthetics
 - This decreases the contaminant burden that must then be removed
7. Chlorhexidine, Betadine antimicrobials to apply to wipes for targeted areas of decontamination; microbiome changes are a concern and still being investigated
8. Moist towelettes
 - They can be used to wipe sensitive areas around the eyes, nose, mouth, and inner ears as well as prepuce and vulva where soaps can be very irritating
 - These can be used to wipe off powder contaminants before they aerosolize, as brushing may put powders into the air and further contaminate personnel

D. Canine Supplies

1. Large absorbent towels - for drying canine after decontamination for drying
2. Dog dryer or shelter from cold
 - In addition to warm water, a heated shelter area is good to continue the drying process during cold weather
 - A groomers dryer will hasten the drying process, but a warm protected environment will be fine along with monitoring the canine for signs of hypothermia (temperature check is the easiest!)
3. Emergency Blankets
 - Protection if wet in a cold environment
4. Scissors
 - Bandage scissors are preferred as they have a blunted tip that won't cut the skin when taking off bandages
 - Never shave or use clippers to remove hair to skin level, if possible, as this may cause abrasions and worsen contamination
 - Use to remove contaminated outer fur of thick caked-on debris not amenable to wipes, vacuum, or repeated pinching to milk substance away from skin
5. Muzzles
 - 6 cage muzzles, 2 each various size
 - We use basket muzzles so the canines can still pant if needed as well as receive some water decontamination through the muzzle
 - Intended use is for known aggressive canines, or questionable situations when the handler is not present and another handler unavailable
 - Aggressive canines that cannot be muzzled may need to be contained in an area (tied in a safe spot or kenneled) until qualified personnel can help handle them for decontamination
6. Leashes
 - Disposable leashes can be used as a collar and leash combination to replace contaminated leashes and collars that must be removed and cleaned or replaced

Low Water-Low/No pressure Kits can be made from these materials

Waterless Decontamination Field Kits

- Under military research and development
- Own version can be created from these materials and placed in an appropriately sized pack for transport
- Options for antimicrobial treated wipes; antidotal wipes

Wet-Dry Vacuum System

- Commercially available at Anivac™ Systems - anivaccorp.com

Dry Vacuum Decontamination

- Nikko Dry DECON System is developed by Chemical Biological Incident Response Force (CBIRF), Naval Support Facility, Indian Head, Md.

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