

Possible Hazards And Risks That Search And Rescue (SAR) Dogs May Face In CBRN Incidents

Arama ve Kurtarma (SAR) Köpeklerinin KBRN Olaylarında Karşılaşabilecekleri Olası Tehlike ve Riskler

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ABSTRACT

Professional search and rescue (SAR) dogs, which are members of urban search and rescue teams with the help of their higher sense organs with rigorous training, are very helpful in finding buried or missing persons in disasters. In these environments where chaos and disorder prevail, it becomes inevitable for them to face very dangerous and risky situations. As a result of a disaster caused by chemical, biological, radiological and nuclear (CBRN) accidents, dangers such as chemical leaks, pathogenic microorganisms, toxins, vectors, and radioactive and nuclear materials in the environment are among the forgotten or neglected facts that SAR dogs affect as well as affect humanity. Working with little or no personal protective equipment during search and rescue interventions makes them completely vulnerable to these hazards. In the limited resources in the literature on CBRN risks and dangers that search and rescue dogs working in disaster areas may encounter, SAR dogs are exposed to many chemicals and toxic agents during these studies, as well as biological hazards such as protozoal or coliform bacterial organisms, and radiological hazards such as the risk of ingesting radioactive materials and breathing dust. their arrival has been determined. With this study, it was aimed to emphasize the dangers faced by SAR dogs and to emphasize what has been done and what should be done to reduce the possible risks. As a result, necessary precautions should be taken to prevent and/or reduce these possible exposures of SAR dogs, and further studies should be carried out for appropriate standard procedures for appropriate rehabilitation and decontamination.

Keywords: CBRN, Hazards, Risk, SAR's Dog.

ÖZ

Sıkı eğitimlerle yüksek duyu organlarının yardımıyla kentsel arama kurtarma ekiplerinin üyesi olan profesyonel arama kurtarma (SAR) köpekleri afetlerde gömülü veya kayıp kişilerin bulunmasında oldukça yardımcı olmaktadır. Kargaşa ve düzensizliğin hüküm sürdüğü bu ortamlarda oldukça tehlikeli ve riskli durumlarla karşı karşıya kalmaları kaçınılmaz hale gelmektedir. Kimyasal, biyolojik, radyolojik ve nükleer (KBRN) kazalar sonucu oluşan bir afet sonucunda ortamda kimyasal sızıntılar, patojenik mikroorganizmalar, toksinler, vektörler ve radyoaktif ve nükleer maddeler gibi tehlikeler insanlığı etkilediği gibi SAR köpeklerinin de etkilemesi unutulmuş veya ihmal edilen gerçeklerdir. Arama kurtarma müdahaleleri sırasında az ya da hiç bulunmayan kişisel koruyucu ekipmanlarla çalışmalarını bu tehlikelere karşı tamamen korunmasız hale getirir. Afet bölgesinde çalışan arama kurtarma köpeklerinin karşılaşabileceği KBRN risk ve tehlikeleri ile ilgili literatürde sınırlı kaynaklarda SAR köpeklerinin bu çalışmalar sırasında birçok kimyasal madde ve toksik ajanlara maruz kalmasının yanısıra protozoal veya koliform bakteriyel organizmalar gibi biyolojik, radyoaktif madde yutma ve toz soluma riski gibi radyolojik tehlikelere karşı karşıya geldikleri belirlenmiştir. Bu çalışma ile SAR köpeklerinin karşılaştığı tehlikeler vurgulanarak olası risklerin azaltılması için neler yapıldığı, yapılması gerektiğinin vurgulanması amaçlandı. Sonuç olarak SAR köpeklerinin olası bu maruziyetlerinin önlenmesi ve/veya azaltılması için gerekli önlemler alınmalı, uygun rehabilitasyon ve dekontaminasyon için uygun standart prosedürler için ileri çalışmalar yapılması gerekmektedir.

Anahtar Kelimeler: KBRN, Tehlike, Risk, SAR Köpekleri.

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INTRODUCTION

According to the United Nations, disasters are defined as all kinds of natural, technological, human-induced events that cause physical, economic, and social destructions at a level that can stop or disrupt the normal life of people, and are too large to cope with the current opportunities.¹ Generally, disasters are divided into two main groups as natural disasters and unnatural (human-induced and technological, artificial) disasters, according to their causes. Geological and meteorological disasters are classified as natural disasters. Human-induced and technological disasters, on the other hand, cause loss of life and property such as industrial, mining, transportation, chemical, biological, nuclear, and radiological accidents, major fires, wars, and cyber threats caused by human activities (accidentally or deliberately) or triggered by natural disasters which cause social, economic and environmental and health deterioration.²

CBRN

Although CBRN (chemical, biological, radiological, nuclear) substances are used and stored as products or intermediates in home, industrial production, health sector, laboratory, nuclear power plants, and scientific research to help and serve humanity in our daily life, intentional, accidental or natural spread as a result of disasters can cause great disasters.³

CBRN agents have also come across wars, disturbances, riots, acts of terrorists and dictators, poisoning and executions from the past to the present, using such substances to reduce the enemy's fighting power, to neutralize the enemy, to frighten, to haunt and to break the enemy's resistance.⁴

CBRN agents can be in gas, aerosol, or liquid form. Entry routes into the body are through the skin, eyes, and respiration, and digestion; In vapor, gas, and aerosol form, it is taken into the body by inhalation, in the form of solid or liquid particles through the skin, if contaminated with food, through digestion. Scented/ odorless,

Colored/colorless available in different physical forms.⁵

Chemical hazards include toxic chemicals produced, used, transported, or stored, which, if exposed, could cause death or other harm. This includes research that poses a collective hazard as chemical weapons agents, chemicals, or toxic industrial chemicals developed or manufactured for use in industrial activities. Biohazards include any organism or substances derived from an organism that poses a threat to the health of any living organism. Radiological hazards include ionizing radiation that can be damaged, injured, destroyed by external exposure, or cause radiation from radioactive materials in the body.⁶

Natural disasters can cause major accidents in chemical plants and lead to the release of hazardous substances, leading to fires, explosions, or toxic spread. Chemical releases complicate the response to natural hazards and potentially increase the disease burden associated with these hazards.^{7,8}

Biohazards constitute an important source of risk that can result in disasters or emergencies. It is of organic origin and includes danger to pathogenic microorganisms, toxic substances, or vector-borne diseases. It also poses a risk to animals and plants, including livestock.^{9,10}

Radioactive materials have two dangers, internal and external exposure. External exposure or contamination can be caused by radiation that may be harmful to the body emitted from radioactive materials such as gamma emitters. Proximity to source and elapsed time affect the magnitude of the danger. Radioactive material can also be dangerous if taken into a person's body through inhalation, swallowing, or open wounds. This is called internal exposure or contamination. Inhalation of radioactive material through a fire of about 100 meters or an explosion containing a very dangerous source could potentially cause serious deterministic health effects.¹¹

Such events are characterized by the inclusion of CBRN agents such as toxic (toxic) and hazardous chemicals/ materials, chemical and biological warfare agents, or radiological materials. People to CBRN incidents and substances through industrial accidents; eg 2011 Fukushima Daiichi nuclear disaster, 1986 Chernobyl disaster, 1989 Exxon Valdez Oil spill, due to wars; for example, the 1991 Gulf War, the 1945 atomic bomb of Hiroshima and Nagasaki, the use of mustard and tear gas during World War I or terrorism incidents, 1999 Istanbul earthquake Tüpraş explosion; For example, they may be exposed to the 2001 USA Anthrax attacks, the 1995 Tokyo sarin attacks.¹² The Corona pandemic we are experiencing today is also a CBRN event.

Search and Rescue Dogs

The use of dogs for search and rescue (SAR) was first recorded in the 1800s, but anecdotal evidence suggests they may have been used 200 years ago. Stories of heroic dogs during World War (WW) I and WWII represent some of the modern manifestations of organized SAR. Known as ambulance and Red Cross dogs, these military dogs were used on the battlefield to locate the wounded and provide first aid supplies.¹³

The body structure of dogs has developed to run fast at long distances, their eyes to determine the location of prey, their snout to follow prey tracks, their ears to locate their prey and other predators. These senses determine the dog's behavior within the framework in which they perceive the environment. The senses are ranked as sniffing, hearing, and seeing in order of importance in interaction with the environment. Dogs help us in many areas of life, although search and rescue come when it comes to helping humanity. Dogs help people in early diagnosis by sniffing the breath and sweat of patients with lung, colon-rectum, and bladder cancer by being subjected to hunting, forensic cases, search and rescue, and special training, even determining low blood sugar, pregnancy, and detecting corona today.¹⁴⁻¹⁹

Besides, disabilities caused by spinal cord injuries, such as multiple sclerosis, Parkinson's, and Alzheimer's. They provide psychological support to people with their developed senses in diseases. Specially trained dogs. They warn patients and their relatives about contractions, seizures, and pre-crisis situations by recognizing and analyzing changes in the patient's behavior, gestures and respiration beforehand. So how do dogs achieve this? Dogs' sense organs are the same as humans, but more powerful. This difference can be explained by the development of organs in line with needs.^{14,20-21}

Vision: Full visual function in the eyes starts from the age of six weeks. The fact that the eyes are located in the front and both sides of the head provide dogs with a wider vision angle than humans. The cornea of the eye is larger than that of humans and allows more light to enter the eye, while the pupil opens to the end in the dark, providing the eye with a quality vision even in very little light. Their ability to see fine details is weaker than humans. They can only detect black, white, and gray tones (dichromatic).^{14,22} Dogs are better able to perceive the same image with about three times less light than humans. Therefore, dogs can easily perceive the shape and movement of the prey even in the dark at night.^{14,23} Since the dog's eye is sensitive to the movement of the object rather than the detail, it may not be able to see a creature standing still at a certain distance. It has been proven by tests that dogs are unable to identify their owners standing still at a distance of 275 m, whereas a shepherd is noticed by his dog when waving from a distance of 1610 m. Dog breeds may have different priorities for using their senses in their response and behavior to the environment. While some breeds such as Greyhound use their vision skills more, some breeds such as Terrier prefer their sniffing ability.¹⁴

Smell: The sense of smell is very developed in dogs and plays a major role in many behaviors. Often they perceive their environment with their sense of smell. The

sensitivity of the sense of smell varies according to dog breeds. There are approximately 5 million olfactory receptors in the human nose. In dogs, this number is 125 million cells in the Dachshund, 147 in the Fox Terrier, and 220 million cells in the German Wolfhound. Besides, the surface area of the olfactory epithelial layers in the nasal cavity is 3-4 cm² in humans, 18-150 cm² in dogs, and the olfactory center in the brain is approximately 10 times more in dogs than in humans. If the length of the nose, dark pigment, and wetness are added to these, it is obvious how superior dogs and humans are in terms of smell.^{17,24} Scientific studies reveal that dogs are 100-1000 times more capable of detecting specific and predefined odors than humans.^{14,25} While dogs' sense of smell is used to find mushrooms under the ground in France and Italy, it has been used to detect gas leaks in Denmark and the Netherlands. In addition to their ability to detect odors, dogs also can distinguish and track them. As a matter of fact, from the detection of harmful insects in plants to mine detection, the ability of dogs to distinguish and monitor scent is used in approximately 30 areas. These superior abilities are evident in the incidents of dogs trained on certain subjects such as the presence of drugs, explosives, and tracing of human sweat.^{14,24-26} In recent years, this incredible ability has been used to determine paralysis (contraction) events seen in some diseases, hypoglycemic attacks in diabetic patients, attacks seen in malignant tumor patients (melanoma, and seizures in diseases with epilepsy. It is explained that dogs detect changes in the density of some chemical substances in the body with their superior sense of smell before these attacks. Studies show that specially trained dogs can detect even very small concentrations of chemicals. These features are also used in narcotic operations and in determining the location of explosives.^{14,27} It is reported that tracing dogs can easily detect chemicals in concentrations far below those that the human nose can detect. A study on humans revealed that dogs can easily distinguish family members, siblings, and even identical twins by scent.

This research also proves that dogs can distinguish a particular smell among many different scents.^{14,16,28} In some studies, it is reported that dogs sometimes use their sense of sight to locate a hidden object during training, but mostly use their sense of smell. The German Shepherd Dog has been reported to have 220 million scent receptors in its nose and ranked first among dog breeds, although its main task is a shepherd dog.^{14,17,24,27}

Hearing: Similar to the sense of smell in dogs, the sense of hearing is very well developed and they can hear more distant and higher frequency sounds than humans. The highest hearing capacity in humans decreases to 30,000 fr/sec in childhood, 20,000 in young ages, and 12,000 fr/sec in old age. In dogs, this figure rises to 35,000-40,000, and even up to 100,000 fr/sec in recent studies in Russia. They make use of these abilities while capturing prey that makes high-frequency sounds. The ear structure in dogs is suitable for hearing sounds coming from a long distance and is approximately 4 times more than humans.^{14,29}

Taste: Dogs' sense of taste from food occurs by smelling and tasting like humans. Dogs have fewer taste receptors in the mouth than humans. There are 9,000 taste buds in the tongue in humans and 1,700 in dogs. There are two types of receptors in taste buds. These are sugar receptors and amino acid receptors. Sugar-sensitive receptors can detect molecules in the sugar structure found in fruits and some vegetables. Receptors sensitive to amino acids, on the other hand, are sensitive to specific amino acids, such as phosphoric acid, carboxylic acid, nucleotide triphosphate, and histidine, which are mostly found in meat and meat products.^{14,26,27}

Touch: Since dogs are a social animal species, they communicate with other dogs and people by their sense of touch. Therefore, a sense of touch is important for dogs. Studies on human and animal communication have been reported that light stroking and touching cause a decrease in the dog's heart rate and blood pressure by stimulating the nervous system, as well as

loving and talking to a dog causes slowing of heartbeat and a decrease in blood pressure in humans. Dogs are also capable of discovering and learning their environment through touch. In the dog's body, there are body parts that are sensitive to touch, such as the front part of the upper jaw, which has a rigid structure around the nose and nose, covering long hairs. The skin in the area of the tip of the nose and the long hairs on the right and left is densely equipped with sensory nerves and are very sensitive to environmental effects. These long hairs can be moved in the desired direction with the help of facial muscles. Although the exact function of these hairs is unknown, it is believed to provide information to the dog about his environment.^{14,29}

Other Abilities: It has also been reported that dogs can easily learn repetitive words because the hearing center in the brain has developed. They can express themselves with body language. Dogs are sensitive to earthquakes and storms and can sense them in advance. It is stated that dogs also have senses similar to the sixth sense. They report earthquakes by howling and storms with bitter barking. Dogs' jaws are developed in the direction of biting, tearing, and chewing, they can bite with a pressure of 20 to 165 kg with their powerful jaws.^{14,26,28}

Potential CBRN Risks and Hazards in Search and Rescue Dogs in SAR Operations

Highly-trained search and rescue (SAR) dogs are indispensable members of urban SAR teams responding to a variety of natural and man-made disasters. Dogs, which are macrosomic animals, have a very good sense of smell. This indicates that dogs can be useful in detecting cancer cells, explosives, drugs, or corpses. Trained dogs are effective in harsh weather conditions. Search and rescue dogs are trained to find living / non-living people. Often they work without any protective equipment / in inadequate disaster areas in areas deemed safe or inaccessible where people are in short supply. A keen sense of smell, perfect balance, and a strong desire to please people are the traits that have

made dogs invaluable for search and rescue (SAR) operations since World War I.^{30,31}

Large-scale disasters; causes the release and mixing of dozens or even hundreds of chemicals and potential contamination of disaster areas with many hazardous chemicals and substances. The use of dogs in the teams participating in the studies in the military, law enforcement, and public health roles puts these animals at risk of exposure to biological and toxic agents.³² Since search and rescue dogs frequently lick their noses while working, they have a much higher potential for oral exposure to toxic substances than their caregivers.³³

Searching, in particular, through piles of rubble requires caution and can be dangerous for the dog. The animal may need to work alone as the dog groomer cannot enter the disaster area in some cases for safety reasons and must only move along designated paths.³¹ During operations, standard policies and procedures require dogs to be free of equipment that could get stuck on debris.³⁰ Dogs have been trained to trace the location of dangerous and toxic odorant molecules including explosives, illicit drugs, land mines etc.³⁴

It is not possible to estimate all the potential toxicological hazards that search and rescue dogs carrying out search activities in urban disaster areas may encounter while searching. Gases of concern to search and rescue dogs in urban disaster areas include hydrogen sulfide, halogenated gases (chlorine, bromine, and fluorine), carbon monoxide, hydrogen cyanide, and freon. Dogs participating in urban disaster response may be exposed to toxic substances through the skin. It is necessary to bathe dogs regularly to prevent the absorption of particles and toxic substances through the skin. Another concern is ocular exposure. The eyes should be washed regularly with saline solution to remove ocular irritants.³³ Disasters from terrorist attacks such as chemical warfare and the destruction of large structures are considered the most dangerous missions. The presence of dust, harmful odors, and particulate matter in the debris

area pose harsh conditions for dogs. Dogs do not use breathing apparatus to perform their olfactory functions on the scene, which can leave them vulnerable to respiratory-related risks. Dogs exposed to chemicals or biological hazards may need additional tests and treatments.³² Rural search activities can result in unique toxin exposures for search and rescue dogs. In addition to chemical toxins, poisonous animals and plants pose a risk. Scorpions, bees, snakes, spiders, and other animals can poison the dog and potentially cause death.³⁴

Waterborne pathogens such as Salmonella, Shigella spp, Giardia lamblia, and Leptospira can cause disease in dogs through ingestion of contaminated water in an environment of flooding and poor sanitation. Most dermal exposure to chemical agents causes direct injury or irritation to intact skin, while lipophilic agents can be absorbed through the skin, leading to systemic toxicity.³⁵ Concerns about floodwaters for dogs during the deployment of search dogs at the scene, following Hurricane Florence; Contamination with natural gas and petroleum chemicals, radiation from healthcare sources, pesticides and fertilizers, coal ash heavy metals, lead, and asbestos. Besides, crocodiles can pose a risk to aquatic snakes, fire ants, fleas, ticks, mosquitoes, bees, and wasps, which are supposed to be poisonous. Endemic diseases include tick-borne (Borrelia/Lyme, Anaplasma, Babesiosis, Ehrlichiosis, Rocky Mountain Spotted Fever and Tularemia), transmitted mosquito (Heartworm disease, West Nile Virus and Eastern Equine Encephalitis), and water-borne Leptospirosis (from humans/zoonotic). 42% of dogs on duty at the scene after Hurricane Florence went through decontamination.^{35,36,37}

Environmental hazards have been a major concern for aid workers after the terrorist attack on the World Trade Center on September 11, 2001. The building collapse and fire created a hazardous environment for dogs working with emergency response teams, exposing them to the toxic chemical mixture. Quinolone, 3-methyl quinoline,

isoquinoline, diphenylamine, surfinol, and 2-(1-phenylmethyl) phenol were found at the scene in both dogs with long exposure and short-term exposure.³²

Following the 2014 State Route 530 landslide, briefings were given to the dog managers on the safety and hazards for 25 search and rescue dogs deployed in Oso, Washington. Topics covered in the briefings, prevention of hyperthermia and hypothermia, dust hazards that can cause eye irritation, gasoline, oil, antifreeze and other chemicals, protozoal and bacterial organisms (e.g. Giardia sp, Leptospira spp, and coliform bacteria), poisonous and dangerous plants (for example, poison oak, poison sumac, and blackberry thorns) and free-roaming local dogs in search areas. All 25 search and rescue dogs were contaminated after each shift.^{35,37}

Medical and industrial sources are possible contaminants as they contain radioactive material. Because there is a possibility of damage by a flood, mudslide, or any other event. Dogs appear 25% to 70% more sensitive than humans to the acute effects of exposure to the same level of radiation as humans. This range is due to different effects on various body systems. There are delayed effects, the specific symptoms are dependent on exposure and many factors related to the survivor. Treatments are similar for humans and dogs.^{36,37}

Search and rescue dogs with suspected toxic exposure should be decontaminated immediately before being transferred to the veterinary hospital.³⁴

Failure to properly decontaminate infected dogs can have negative consequences for themselves and all teams and can render all or part of the resources required for a disaster response unusable.³⁰

SARS-CoV-2 has been found to reproduce poorly in dogs, pigs, chickens, and ducks, but allows for infection in ferrets and cats.³⁸ The transmission modes of SARS-CoV-2 are suitable for human transmission to dogs and cats. Although the routes of

transmission are not fully determined, the virus is mainly transmitted through respiratory droplets that are spread during coughing, sneezing, speaking, or breathing. Recent observations also indicate that there is

a transmission of fomites from hand to mouth, via the eye conjunctiva, or by touching the nose with hands contaminated with saliva or respiratory droplets.^{36,39,40}

CONCLUSION AND RECOMMENDATIONS

Search dogs generally do not wear personal protective equipment, so their bodies are exposed to various rashes during search operations. There is a need to develop personal protective equipment that does not interfere with the ability of dogs to smell, hear or work. Boots are the only personal protective equipment (PPE) available for dogs to protect their claws. These boots are used to reduce the feeling of dogs and reduce the flexibility of their paws. For example, it reduces the burning sensation of their paws to avoid dogs stepping on hot spots.

PPE for search and rescue dogs; It should be a temporary material that prevents the absorption of hazardous substances and can be easily installed and removed. Another recommendation is to efficiently moisten or cool dogs in an environment with extreme heat conditions (vests, spray, patches dispensing electrolytes, thin gel packs, etc.). The third recommendation is to apply a protective coating to the dog's paws. The coatings to be applied must allow dogs' paws to breathe and must be washed or immersed

during decontamination. Another recommendation is a dog life jacket with GPS tracking that meets some PPE needs. Research and innovation are needed to optimize canine decontamination processes and develop improved protocols.

Besides, we believe that technological developments should focus on this area, and the production of robots whose efficiency will be at least as much as search and rescue dogs should be designed and made as soon as possible. Although dogs make our work easier in this area, it is thought that the use of robots will become much more common in the future.

In addition, it should not be forgotten that during search and rescue activities, dogs, which are known to be very emotional, as well as humans, also experience psychological injuries as well as physical injuries. There should be rehabilitation centers against these situations. It should not be forgotten that it is our duty to protect our friends who are always with us to help us.

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