Emergency and First Aid in Cases of the Use of Chemical, Biological, Radiation, and Nuclear Weapons

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Abstract

Chemical, biological, and radioactive substances purposely, accidentally, or after a natural disaster cause a lot of harmful effects on people and the environment. To prevent this harmful effect or at least minimize it, precautions must be immediately taken. These kinds of incidences have different importance for hospitals as victims apply first to hospitals, and they can decontaminate staff therein. Thus, different decontamination areas should be built in hospitals. Herein we discuss the decontamination that should be applied to victims. We provide information about the effects of nuclear weapons and the first aid rules for treating victims exposed to them. A clinical sign of radiation exposure is more obvious than that for biological and chemical weapons and because it can be detected more easily, fighting the clinical effects of nuclear weapons is easier than fighting the clinical effects of biological and chemical weapons. Biological weapons spread very easily and very rapidly from person-to-person, and the mortality rate can be high. Further, it causes a chaotic effect on society. Considering this feature of biological weapons, we will emphasize a number of precautions. Carrying and hiding toxic chemical weapons is easy. We will explain what should be done in case of exposure. *(Eurasian J Emerg Med 2016; 15: 90-3)*

Keywords: CBRN, decontamination, emergency and first aid

General Information and Decontamination Rules

A major event caused by an intentional or accidental spreading of chemical, biological, radioactive, or nuclear materials leading to harmful and hazardous situations for humans and the environment is termed a chemical, biological, radiation, and nuclear (CBRN) event. The pollution of a particular region, humans, buildings, soil, and water resources by exposure to CBRN materials is called contamination; the physical and chemical cleaning procedure performed with the purpose of eliminating this contamination is called decontamination (1, 2).

The Hospital Disaster Management Center Presidency should, as a priority, make a joint action plan with organizations, such as the Governor's Crisis Management Center, the Provincial Directorate of Health, the Disaster and Emergency Management Authority, the Turkish Atomic Energy Authority, and the Ministry of Environment, to determine the precautions needed to be taken against exposure to CBRN materials during a disaster and should act accordingly. A separate section should be reserved for CBRN materials in the preparation of hospital disaster plans (HDPs). The chiefs of logistics and finance should ensure the supply of the necessary equipment and materials with the knowledge of the HDP president. At least two decontamination areas, one stationary and one mobile, should be built in hospitals. Every hospital should exercise CBRN drills once every two years. Additionally, agreements should be made with organizations capable of cleaning these materials when contamination occurs. The telephone numbers and addresses of these organizations should be present in the emergency communication guide (2-4).

Materials required for decontamination:

- Protective clothes, gloves, caps, boots, and overshoes for personnel;
- Masks preventing contamination by inhalation for personnel and portable ventilators;
- Bathing compartments;
- Pressurized showers or similar bathing systems;
- Labels indicating contaminated and decontamination areas, together with materials, such as barriers, barricades, and strips, to prevent entrance to these sites;
- Wastewater collection tanks;
- Special bags, containers, and zones for contaminated equipment;

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- Laboratory equipment for sampling contaminating substances and predetermined sampling and sample storage protocols with the aforementioned organizations;
- Decontamination and cleaning materials;
- Radioactive substance detectors.

If decontamination is performed outside the hospital:

- Heating equipment and lighting system;
- Towels, clothes, and gas masks for patients;
- Wastewater collection tanks;
- Appropriately equipped compartments for patient privacy.

Immediately after the CBRN event, most of the injured tend to leave the event scene, and they present to the emergency services by their own means within the first few hours of the event. Most of the presenting individuals will be asymptomatic and unexposed to the agent. These individuals result in the unnecessary use of hospital resources. Because the first intervention is made by emergency service staff for injured patients, they constitute the group with the highest risk in terms of secondary contamination. To prevent secondary contamination, other entrances to the hospital should be brought under control, the security of the decontamination area should be ensured, and the patients should not be allowed to enter the hospital without decontamination (5). The personnel who are planned to work in the decontamination area should be trained beforehand, and they should not contact the patients without using personal protective equipment. In this area, the patients should be completely undressed. Their clothes should be put inside a medical waste bag, with its mouth sealed and then left in the controlled region. Because many chemical agents can lead to explosions or the release of toxic gases when they react severely with water, the patient is washed with unpressurized water for at least 15 min from the head to the toe including all body cleavages. If the chemical agent is a solid, it is first wiped gently and removed; then, it is washed. For removing oily or water-insoluble agents, a soap or shampoo can be used. The eyes should be washed with plenty of water. For the decontamination of agents ingested into the gastrointestinal system, the patient should not be forced to vomit; a glass of plain water can be drenched, and activated charcoal should be administered orally with a dose of 1 g/kg. After washing, drying is performed; to be sure that the patient is fully cleaned, measurements are taken, and the patient is then covered. In addition, in this area, basic medical care, such as opening the airway and respiratory and circulatory support, should be given simultaneously (2, 6, 7). After the completion of decontamination, the patient is sent to a safe zone for triage, treatment, and transport. All personnel who have made contact with the polluted patient are taken to the safe zone, following their personal decontamination. The wastewater in the decontamination area should be taken care of to ensure that it does not mix with the city sewer (8-10).

Emergency and First Aid in Cases of the Use of Nuclear Weapons

Nuclear weapons contain hundreds of kilos of conventional explosives, and explosions may occur as a single big explosion or as multiple small explosions. Although it has many effects, such as the strike, thermal radiation, high temperature, electromagnetic wave effects, and radioactive fall-out, the most hazardous effect is ionizing radiation. This ionized radiation is composed of alfa, beta, gamma, X-rays, and neutrons (Figure 1). These have short wavelengths, high energy, and high frequency. Thus, they show effects at the cellular level. While in the early period, exposure shows an effect on short living cells, with rapid regeneration like in the hematopoietic system, it also harms the central nervous system cells, which proliferate slowly in the late period (11).

First aid against the effects of nuclear weapons is similar to injuries and burns due to other causes. For decontamination processes, the working areas should be identified first, and the removal process of radioactive material should be initiated. Thus, triage and decontamination areas in the entrance of emergency services must be done. Decontamination should be initiated after patients become stable. Staff should interfere to victims after they take individual protective precautions. As a first step, the clothes of the patient should be removed and placed inside special radiation-retarding containers, and thereby decontamination is completed to an extent of 95%. Then, as the second step, the patient's face and hands are washed and decontamination is completed to an extent of 98%. As the third step, the hair and scalp are washed. The surfaces exposed to nuclear pollution are brushed or cleaned with hot soapy water solution, or they are immersed inside the solution. Mostly, contaminated victims should be decontaminated first and the integrity of the skin should be protected. Surgical debridement can be done in contaminations that cause disruption in the integrity of the skin. The wastewater is drained from a secure area (7, 9).

Emergency and First Aid in Cases of the Use of Biological Weapons

Biological weapons are pathogen and contagious bacteria, parasites, fungi, protozoa, rickettsia, viruses, and toxins. Besides their mass-destructive characteristics, the other properties of biological weapons are that they can be easy and inexpensive to obtain, the effects can be permanent and progressively increasing, their ease of use, and delayed awareness of their use (12). Centers for disease control and prevention centers in the USA classify biological weapons according to their virulence, mortality, and chaotic condition in society (Table 1) (13).

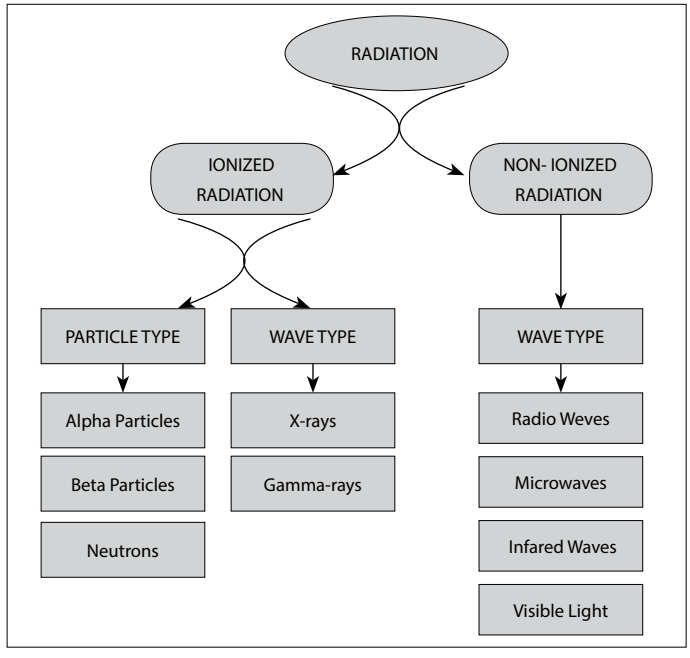

Figure 1. Types of radiation

Table 1. Classification of biological agents (13)

Agents Group A	Agents Group B	Agents Group C
Plague (*Yersinia pestis*)	Brucellosis (Brucella species)	Yellow fever
Botulism (*Clostridium botulinum*)	Ricin toxin (*Ricinus communis*)	Nipah virus
Anthrax (*Bacillus anthracis*)	Shigella	Tick encephalitis viruses
Smallpox (*Variola major*)	Q fever (*Coxiella burnetii*)	Hemorrhagic tick fever
Tularemia (*Francisella tularensis*)	Cholera (*Vibrio cholerae*)	Multi-resistant tuberculosis
Viral Hemorrhagic Fevers (*Lassa, Machupo, Ebola*)	Glanders (*Burkholderia mallei*)	Hanta virus
	Escherichia coli O157:H7	
	Salmonella	

Table 2. Classification of chemical weapons (15)

Nerve Gases	Blister Gases	Pulmonary Irritants	Blood Poisons	Incapacitators	Vomitive Agents
Sarin (GB)	Sulfur Mustard (HD)	Phosgene (CG)	Cyanogen Chloride	Psychomimetics (3-quinuclidinyl benzilate, LSD)	Adamsite (DM)
Tabun (GA)	Nitrogen Mustard (HN-mustard gases)	Diphosgene (DP)	Hydrogen Cyanide	Opioids and Benzodiazepines	Diphenylcyanoarsine (DC)
Soman (GD)	Lewisite (L)	Chlorine (CL)		Tear Gases Chloroacetophenone (CN), ortho-chlorobenzylidene-malononitrile (CS), Dibenzo [B,F] [1,4] Oxazepine) (CR)	Diphenylchloroarsine (DA)
Methylphosphono-thioic acid (VX)	Phosgene oxime (CX)	Chloropicrin (PS)			

The first thing to do following biological attack is the cleaning of personnel, equipment, water, buildings, and land from the microbes. The immunity should be maintained, known health measures should be applied, and for protection, active vaccination should be performed. Following preventive measures, the patient is evaluated; after providing basic life support, such as airway patency, ventilatory, and circulatory assistance, the decontamination procedure is initiated. The contaminated clothes of the patient are taken off and removed from the field by personnel wearing protective clothing. For decontamination, by using soapy water, laundry bleach, air filters, liquid, gaseous, or aerosol disinfectants, heat and radiation, the biological agent is destroyed or rendered harmless. Following decontamination, patients are isolated and their medical care is provided meticulously (6, 10). Specific and supportive treatment should be initiated based on the detected or suspected biological agent.

Emergency and First Aid in Cases of the Use of Chemical Weapons

Due to their physiological effects, chemical weapons are highly toxic chemical poisons with the capacity of mass killing or injuring living creatures in a very short period; they are also resistant to environmental factors and are easily transported and stored. These substances, which are present as solids, liquids, and gases, enter the body through the mouth, nose and throat, eye, skin, lungs, and digestive system. Classifications of chemical weapons are given in Table 2.

After taking the necessary precautions, the personnel complete the interventions directed to the vital functions (airway patency, ventilatory and circulatory support, and bleeding control), and then, the decontamination process is initiated, and chemical cleaning is done prior to the treatment. Following decontamination, the patient is further evaluated and treated (6).

Nerve gases are the most toxic chemical warfare agents. They directly affect the nervous system by inhibiting acetylcholinesterase and paralyze the vital functions. The specific antidote is atropine, and the first thing to do is use atropine autoinjectors. The gas residue, possibly present on the face, eyes, and open parts of the body, should be cleaned off by washing with plenty of water or by the use of a decontamination towel. If no water is available, cleaning should be done with a non-contaminated paper or cloth. Vesicant gases are strong alkylating agents, and they have cytostatic, mutagenic, and cytotoxic effects. They are lipophilic and are absorbed through healthy skin. There is no antidote for mustard gases, and victims should be decontaminated with water and soap immediately after exposure, and supportive treatment should be given. Lewisite is a vesicant with arsenic content and is more toxic than mustard gases. After the victim is decontaminated, BAL (Dimercaprol) 4–5 mg/kg IM should be used.

Suffocating gases (pulmonary irritants) enter the body via respiration and lead to anoxia by increasing capillary permeability. The patient should be allowed to rest and kept warm, and inhalers and systemic steroids should be administered, regardless of whether symptoms are present. Artificial ventilation is contraindicated. Blood poisoning gases prevent functions of the systems by inhibiting the oxygen consumption of somatic cells and affecting the circulatory and respiratory systems. The patient should not be moved, and he/she should breathe through a mask, in which an ampule of amyl nitrite has been sprinkled. Calmative

agents are chemical warfare agents that disable personnel by causing temporary physiological effects (paralysis, blindness, deafness, etc.) and mental effects or creating both effects. Spontaneous recovery usually occurs within 12 h. To sedate the patient, diazepam or sodium amytal is used. Tear gas is used more commonly for suppressing riots. No treatment is required. When exposed to clean air, the symptoms disappear within a few hours. A protective mask is used as a preventive measure. If the eyes are contaminated with a chemical substance, they should be washed with plenty of water, and the eyes should be closed following the administration of a tetracycline eye ointment (6, 10, 14, 15).

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