

Current health threats connected with the use of biological weapons

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Summary:

Taking into account the possible scale of threat to health connected with the use of biological weapons, it is necessary to provide physicians, nurses and medical rescue workers, including students, with the corresponding theoretical and practical knowledge in the area of bioterrorism. It is crucial to introduce issues concerning biological weapons to the curricula at each level of education.

Key words: threats to health, biological weapons, bioterrorism.

Proper education and training of health professionals should help all people in the world to achieve optimal state of health. This is accomplished by the promotion of the health of people throughout their lives and reduction of the number of cases and the level of suffering caused most often by illnesses and injuries. For this reason, this chapter presents the main aspects of the types and the applicability of biological weapons. It also presents the principles of dealing with health threats associated with bioterrorist attacks.

This knowledge is essential for the organization of health care, where the nurse plays a key role. In particular, district nurses and nurses cooperating with GPs may have frequent contact with people who need medical assistance, and thus they can observe changes and abnormal responses of the body related to the effects of various biological pathogens.

The assumptions of a joint health policy program “*Health for all*” for the citizens of the European Region “*Health-21*” were adopted by the WHO European Regional Committee in September 1998. Twenty-one tasks (goals) to be achieved in this century were defined. One of the objectives of this program concerns the development of human resources for health care, and reads as follows: *by 2010, all Member States should enable health care professionals and professionals in other sectors to acquire knowledge, skills and attitudes appropriate for the protection and promotion of health* [1].

Particular attention is paid to the qualifications of doctors and nurses working in primary care, as they should be a “*center of the entire network of services*”, necessary to perform the tasks resulting from the adopted program. The key tasks of GPs and nurses are listed in the program documents of

the WHO. It is stressed there that these professionals must have necessary knowledge and skills.

Proper education and training of health professionals is included in the *Health – 21* policy and its “permanent objective” that is “to achieve optimal health for all people” through implementation of two tasks, namely promotion of the health of people throughout their lives and reduction of the number of cases and the level of suffering caused most often by illnesses and injuries” [1].

Currently, the greatest potential health threat to society, related to the possible use of biological agents, may be biological terrorism. In the era of advanced research and development of the media, citizens of developed economies seemed to be free from fear and confident that nothing could surprise them. However, the events of September 11, 2001, and those which followed them, proved that a new, radical form of terrorism was born, the promoters of which are willing to use unpredictable and nearly unknown weapons – biological weapons.

At the moment, there are no other weapons that would be so easy to hide, inexpensive to manufacture and yet able to cause such great losses in people. Detection of the fact of their use is extremely difficult, and since there is little public awareness of the consequences of its use and methods of dealing with risk, the mere mention of the possibility of a bioterrorist attack causes panic disorganizing the work of all emergency staffs and medical services.

Signing and ratification by a majority of countries of international agreements on the prohibition of improvement, production, storage and use of biological and chemical weapons limited only the probability of their use, without giving a guarantee of the weapons not being used, because there still exists a group of countries, among others Iraq, Iran, Libya, North Korea, where such weapons are produced and improved. Weapons of mass destruction are also present in the arsenals of many other states and they can be used in a possible conflict.

It is very difficult to predict an act of biological terrorism or a threat of biological crime. Even in the case of a threat of biological attack, the

type of biological agent and its application may not be known, which reduces the effectiveness of protection measures. It would be possible to use security and protective measures, significantly reducing the number of potential victims of the expected attack, only if the time and place of the use of the biological agent as well as its nature were known.

When considering issues related to biological weapons, it should be noted that with the development of chemistry and biochemistry, the differences between chemical and biological weapons are becoming increasingly blurred. More and more germs are being replaced with toxic products of their metabolism, derived synthetically. Therefore, weapons are no longer divided into chemical and biological ones, and a general term is used to describe them – CB weapons.

Biological and chemical weapons consist of three basic elements:

- 1) active agent;
- 2) container with this agent;
- 3) medium.

Chemical warfare (chemical weapons) are toxic compounds, which due to their physical and chemical properties are suitable for military use. They are characterized by lethal or harmful effects on humans, animals or crops and are usually liquids and solids, less frequently gases, and they occur in the form of vapors and aerosols [2].

All chemicals used as weapons of mass destruction, must have the following characteristics:

- 1) toxicity;
- 2) fast or latent (chronic) effects;
- 3) no organoleptic characteristics;
- 4) easy permeability through different materials (textiles, rubber);
- 5) resistance to weather conditions and chemical disinfectants;
- 6) difficult detectability;
- 7) resistance to detonation, temperature, long-term storage

In terms of the mechanism of action, chemical weapons are divided into the following groups:

- 1) irritants;
- 2) psychotoxic;
- 3) vesicant (causing necrosis);

- 4) generally poisoning;
- 5) causing paralysis and convulsions.

Biological weapons are a means of mass infection of humans, animals and plants. Their active agents are biological substances, which include pathogens (bacteria, viruses, rickettsiae, fungi) and venoms produced by bacteria (toxins). The Annex to the “Convention of 1999 on the Prohibition of the Development (...) of Biological and Toxin Weapons (...)” lists the following factors as pathogenic for humans: 9 species of bacteria, 3 species of rickettsiae, 2 species of protozoa, 16 types of viruses, 19 different toxins and 14 viral pathogens of animals and 16 plant pathogens.

However, article I of the Convention allows for research regarding prevention and protection against these factors under the control of international organizations. Yet, we know that increasing the production of dangerous biological agents to a mass scale is not currently a major technical or financial problem (5). Biological agents of mass destruction can be used to achieve the following objectives:

- military – biological war,
- bioterrorism,
- biocrime.

An effective biological weapon is characterized by:

- 1) easy, fast and cheap reproduction of pathogens;
- 2) high virulence of biological agents;

- 3) resistance to adverse environmental factors;
- 4) potential for scattering in the form of aerosols;
- 5) causing disease with a short period of incubation, high infectivity and mortality;
- 6) difficult detectability, in particular with traditional methods;
- 7) potential for causing panic in the civilian population.

In the recent period, dangerous biological agents were divided into three categories: A, B, C. The biological agents of so-called category A (suitable for use in biological war) are one of the following pathogens: smallpox virus, anthrax bacillus, yersinia pestis, tularemia bacillus, botulin and filoviruses (Ebola, Marburg) (4). These factors were given the highest priority because they:

- are easy to spread or easily spread from person to person,
- cause high mortality and can have a big impact on the health of the population,
- can cause panic among people,
- require no special preparation on the part of public services (particularly health care services).

The concept of a biological agent was defined to describe the needs of potential bioterrorist activities. Thus, biological factors are – *“Living organisms or materials derived from them, causing illness or injury to humans, animals or plants, or causing any damage or deterioration of material properties. Biological agents*

Table 1: The main diseases caused by biological agents.

Type of gent Name of disease	Mortality incidence		Time of elimination of a man from the battle field	VACCINE TREATMENT	The risk of infection	The use in biological warfare
	without treatment	with treatment				
BRUCELLOSIS	2-5%	Below 2%	Months or years	available not very effective treatment (antibiotics)	WEAK	aerosol, contaminated water and food
CHOLERA	10-80%	5-30%	Up to 30 Days	available antibiotics sulfonamides	STRONG	aerosol, contaminated water, food and objects
YERSINIA PESTIS	100%	10%	1-2 weeks	available antibiotics sulfonamides	STRONG	aerosol, contaminated water and food
YELLOW FEVER	5-90%	5-90%	10-14 days	mass-produced difficult	NOT AVAILABLE	aerosol, infected mosquitoes
SMALLPOX	25-40%	6-10%	12-14 days	mass-produced difficult	STRONG	aerosol, contaminated water, household items
TYPHUS	40%	5%	Up to 3 months	mass produced antibiotics	STRONG	aerosol, infected lice
BOTULISM	60-70%	60-70%	2-6 months	in the form of antitoxin very difficult	NOT AVAILABLE	aerosol, contaminated water or food

Table 2: Threat category A.

Microorganism	Disease caused	Incubation period	Mortality
Bacillus anthracis	ANTHRAX	1-3	pulmonary and intestinal form about 100%
Clostridium botulinum	BOTULISM	0.5-2	100%
Francisella tularensis	TULAREMIA	1-21, usually 2-7	small
Yersinia pestis	PLAGUE	1-10	pulmonary form up to 100%

Table 3: Threat category B.

Microorganism	Disease caused	Incubation period (days)	Mortality
Burkholderia mallei	GLANDERS	2-5	60-90%
Burkholderia pseudomallei	MELIOIDOSIS	2-6	Over 90%
Rickettsia provazeki	EPIDEMIC TYPHUS	8-15	Up to 30
Coccidioides immitis	COCCIDIOIDOMYCO-SIS	7-28	dangerous if the immunity is weakened

Table 4:

Virus or viral family	Disease caused	Incubation period	Mortality (%)
Arenaviridae	Lassa fever	7-21	30-50
Arenaviridae Junin, Sabial, Machupo	South American hemorrhagic fevers	7-14	About 30 Uncertain data
Arboviridae	Rift Valley fever	4-6	30 (blindness)
Filoviridae	Ebola hemorrhagic fever	3-7	50-90
Filoviridae	Marburg hemorrhagic fever	5-8	30
Ortopoxviridae Poxvirus	Smallpox	4-7	20-40
Equine Morbillivirus	Hemorrhagic fever with acute encephalitis	About 3 (uncertain data)	100

may take the form of liquid droplets, aerosols or dry powders. They can be adapted and used as a terrorist weapon causing diseases such as anthrax, tularemia, cholera, encephalitis, plague and botulism. There are three different types of biological agents: bacteria, viruses, and toxins.” [3]

Currently, the known biological agents can be transferred to humans in two ways: through the digestive tract or by inhalation.

Other methods, such as spreading of infected insects or objects, now only have historical significance because of the limited effectiveness of such actions.

Currently, one can expect the use of biological agents by spraying an aerosol or contamination of food or drinking water.

The term aerosol includes “airborne solid or liquid material, classified as dusts, fumes, mists and vapors, depending on their physical nature, particle size and method of manufacture. Particle size can vary from 0.01 to 100 / μm in diameter.” [3]

Biological agents can be spread anywhere through the air without attracting attention, because they have no taste or smell. The means of transmission may be an airplane, helicopter, or a single man. Objects may be attacked either in the open space, as well as in closed and crowded places – subway, shops, offices.

The following will dominate in the structure of sanitary losses in terms of the factor of destruction and type of injuries, for biological weapons: poisoning 50-70% of losses and illnesses

30-50%; for chemical weapons: poisoning 90-95% and burns 5-10%.

There are biological factors that are considered as a potential threat, weapons of mass destruction including bacteria, viruses, fungi and toxins – Table 3.

Pathogenic viruses classified as destruction “A” could pose a threat to health, considered as a potential biological weapon – Table 4.

Additionally, a potential health threat can be bacterial, plant and animal toxins. They have been summarized in the following table – Table 5.

Symptoms occurring in the body after the use of biological agents:

Pulmonary form of anthrax: fever, cough, chest pain, dyspnea, cyanosis, shock. Death after 24-36 h following worsening of symptoms.

Hemorrhagic meningitis in 50% of cases. Physical examination reveals nonspecific symptoms.

Pulmonary form of yersinia pestis: high fever, headaches, symptoms of toxemia, rapidly progressing dyspnea, cyanosis. Death accompanied by the symptoms of shortness of breath, shock, bleeding. Physical examination reveals consciousness disorders, hemorrhagic lesions on the skin and mucous membranes.

Tularemia: in aerosol infections, symptoms of typhus, fever, headache, cough, symptoms of pneumonia (30-80%). Physical examination reveals typhoid symptoms with no adenopathy.

Smallpox: fever, muscle aches, vomiting, headache, progressing rash 2-3 days later, changing into vesicles. In physical examination rash covering the face, hands and feet.

Botulism: vision disorders, speech disorders, dysphagia, symmetrical descending symptoms, respiratory failure. Physical examination:

Table 5:

Toxin	Toxin source	Toxin characteristics	Lethal dose in µg per kg of body mass
Botulin toxin	Clostridium botulinum	Neurotoxins A, B, E - toxic to humans	0.01
Epsilon toxin	Clostridium perfringens	Neurotoxin; is activated by trypsin in the gastrointestinal tract	0.1
Shigatoxin	Shigella dysenteriae	Inhibits protein synthesis, secondarily damages the endothelial cells of the spinal cord	0.01
Staphylococcus aureus enterotoxin	Staphylococcus aureus	Protein substance, incapacitating agent	Toxic dose 10-15
Abrin	Abrus precatorius	Inhibits protein biosynthesis	0.04
Alphatoxins	Aspergillus flavus, Aspergillus parasiticus	Inhibits protein biosynthesis, strong hepatocarcinogen	3000
Diacetoxins - scirpenol	Fusarium graminearum, F. nivale	Dermatotoxin	4000
Toxin T2	Fusarium: latericum, oxysporum, solani, roseum, tritinctum, viridae, ridinsculum	Dermatotoxins	1200
Ricin	Ricinus communis	Cytotoxin, protein alkaloid derived from ricinus	0.1 per os; 400/L of air, inhalation
Saxitoxin	Protozoa: Gonyaulax, catanella; saxidomus giganteus mollusks	Neurotoxin; causes respiratory muscle paralysis	0.2
Tetradotoxin	Sea fish	Neurotoxin; causes paralysis of respiratory muscle and the respiratory centre	8
Conotoxin	Sea snails conus sp.	Neurotoxin; blocks the sodium and calcium channel; blocks the receptors	6

no fever, no reaction of pupils, paralysis of varying degrees.

Viral hemorrhagic fever: fever, headache, hemorrhagic rash, progressive signs of bleeding, aseptic meningitis, shock, coma. Physical examination reveals progressive hemorrhagic lesions, conjunctivitis, rash on neck and chest [3].

Many countries introduced legislation to enable organization of an effective system of defense against health risks associated with the use of biological weapons, including against biological terrorism. The most advanced country in the fight against terrorism is the United States of America. Active measures in this regard are also taken by: United Kingdom, Canada, France and some other countries such as Poland, Ukraine and Spain.

Currently it is not possible to provide a complete protection for larger, especially accidental human communities against the effects of biological weapons. Vaccines prevent certain diseases, but this way of providing security becomes worthless when the pathogenic agent is not known in advance. In addition, there are no vaccines to many potential pathogens that could be destructive agents of biological weapons. The administration of antibiotics may not be effective until the organism is identified, and will never be successful when we confront strains resistant to antibiotics obtained naturally or by genetic engineering. Antibiotics will not be effective for viral infections either [4,8].

We need a new and broad perspective on the real threat of biological weapons, and a system to prevent the use of such weapons, as well as the most effective procedures for eliminating the consequences of their use. The emergency services and health services should have well-developed and tested procedures of action in circumstances of a threat. Moreover, what is also necessary, is the rapid recognition and accurate identification of risk factors, as well as developed and tested procedures to eliminate the consequences of the use of biological weapons. These actions are related to individual and collective inactivation, and inactivation of the environment, organization of first aid to victims, organization of the system of segregation and transport of patients. It is necessary to keep ready a certain number of beds in well-equipped departments of infectious diseases, which would enable

hospitalization of patients with especially dangerous infectious diseases.

It is also necessary to provide a possibility of quick development of an appropriate hospital base. It is necessary to provide adequate supplies of antibiotics, vaccines and antitoxins [7].

There is advanced research on the assumptions of a system of detection and identification of biological threat agents. It is planned to create an effective system of supervision and constant epidemiological monitoring, designed for fast and reliable analysis of the data indicating an increase in incidence in a particular area, and an efficient flow of information. It is expected that daily reports on the incidence of illnesses should be transmitted according to a simple scheme: from local clinics to district and then to provincial sanitary and epidemiological stations [2,9].

The following epidemiological guidelines suggesting the possibility of a bioterrorist attack may be useful in epidemiological surveillance:

- 1) A large number of patients with similar symptoms
- 2) A large number of cases of unknown etiology
- 3) The occurrence of an unusual disease in the population
- 4) High morbidity and mortality, occurring in connection with the ordinary course of frequently occurring diseases or lack of positive response to routine therapy.
- 5) Single cases associated with infection by rare microbes: smallpox, pulmonary form of anthrax, viral hemorrhagic fevers
- 6) Occurrence of uncommon diseases within the same patient with no explanation
- 7) Occurrence of diseases in unusual geographical areas and seasons
- 8) Diseases of atypical course in the population at age when they normally do not occur
- 9) Atypical symptoms
- 10) Genetic similarity of microorganisms isolated at different times and from different sources
- 11) Isolation of atypical, genetically modified, or previously existing strains
- 12) Stable endemicity in a given area associated with a sudden increase in incidence
- 13) Simultaneous occurrence of similar diseases in areas which are not in contact with one another
- 14) Atypical disease transmission by aerosol, food and water, which may suggest sabotage
- 15) Patients with similar symptoms receiving

- treatment at the same time
- 16) The occurrence of symptoms in persons who previously stayed in air-conditioned rooms, in the absence of these symptoms in other persons
 - 17) Unprecedented cases of illness and death among the animals associated with illnesses and deaths among people

Rules of providing medical assistance in cases of biological and chemical attack should be based on specific assumptions resulting from the necessity to work in extreme conditions (8). Special attention should be paid to the efficient admission and segregation of the infected and determination of the order and extent of medical assistance at different stages of medical evacuation. Quick evacuation is a guarantee of success in the fight against mass losses, and accelerates the correct diagnosis of infection/contamination, and specialist treatment [10].

To sum up, in the case of the use of biological weapons, when the agent used in the attack is not known, or if the agent used was initially described as having an infectious and transmission properties, the rules listed below must be followed:

- Isolation of potential sources of infection from a healthy population;
- Seeking to break the chain of epidemic;
- Treating each person exposed to a biological attack as infected;
- Each symptomatic case of infectious disease should be considered as a consequence of biological attack, or contact with a sick person.
- Performing sanitation procedures for the removal of a biological agent that can infect healthy people, including medical personnel and

the surrounding environment;

- Use of chemo- and immunoprophylaxis in all cases where it is necessary.

Because of the possible scale of the health threats associated with the use of biological weapons, it is necessary to provide nurses with adequate knowledge and expertise on these issues. Bioterrorism issues should be introduced in the curricula at every level of education.

Proper education and training of health professionals should help all people in the world to achieve optimal state of health. This is accomplished by the promotion of the health of people throughout their lives and reduction of the number of cases and the level of suffering caused most often by illnesses and injuries. For this reason, this chapter presents the main aspects of the types and the applicability of biological weapons. It also presents the principles of dealing with health threats associated with bioterrorist attacks.

This knowledge is essential for the organization of health care, where a physician, nurse or paramedic plays a key role. In particular persons involved in the organization of health care in a society, cooperating with GPs, may have frequent contact with people who need medical assistance, and thus they can observe changes and abnormal responses of the body related to the effects of various biological pathogens.

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