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# Rescue operations in biological hazards

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## Summary:

In the last decades, various acts of terrorism have been reported. The most common events involve the use of explosives and chemical warfare agents, while the risk posed by biological agents in the hands of terrorists remains neglected. Appropriate procedures including early risk identification, patient segregation, medical evacuation and disinfection are the key elements of reducing the risk of an epidemic.

**Key words:** emergency service, procedure, terrorism, medical care, biological warfare.

## 1. Introduction

Constant development of global civilisation is accompanied by the increasing risk of terrorist attacks. Thus far, terrorists have been equipped mainly with conventional arms as they are easy to obtain and use. The events of September 11th drew public attention to the risk of terrorist attacks using weapons of mass destruction. Such weapons are defined as "biological, chemical, nuclear and radiological weapons (…) causing mass damage to humans as also as animals, along with large-scale damage and contamination of infrastructure, soil and vegetation" [1]. It is commonly believed, that acts of terrorism using pathogenic agents constitute the highest potential risk for civilians [2].

Terrorists possess high capacity of adapting to new circumstances, hence they constantly attempt to obtain biological weapons, including viruses, bacteria and toxins. Achieving this goal is possible using natural sources or laboratory cultures. Biological weapons are also popular with terrorists thanks to their psychological effect expanded by mass media. Even small quantities of such agents may be sufficient to induce a psychosis capable of impairing the functioning of the state.

Biological warfare agents (BWAs) have several advantages [1,2]. They employ living organisms or toxins produced by those organisms to kill or wound humans and animals. Modern biological weapons provide a multitude of both the exerted effects and the ways of dissemination. Several categories of BWAs may be listed:

- Bacteria – anthrax, brucellosis, plague, typhoid fever;
- Rickettsiae – typhus, Q fever;
- Viruses – smallpox, influenza, yellow fever, the Ebola, Marbug and Lassa viruses, encephalopathy;
- Toxins – Shiga toxin, botulin toxin, aflatoxin;
- Fungi – coccidioidomycosis.

By comparing conventional weapons, which pose risk to several hundred people over a short period of time, and biological weapons, which may be dangerous for more than 10,000 people, depending on the site and the time of exposure, the immense advantage of the latter type may be demonstrated. Moreover, the effects of exposure to biological agents may be delayed in time and occur even after more than 10 days of exposure.

## 2. Biological attack detection

Managing victims of a putative or confirmed bioterrorist attack should not be based on ad-hoc plans but has to follow strictly defined procedures.

Coordination of all types of public services responsible for the reaction to bioterrorist attacks, according to the Act of 26 April 2007 on Crisis Management, is a duty of crisis managements centres [3]. Introduction of epidemiological early warning systems is an important element of this duty [2,4].

In every case of a potential terrorist attack, early warning system is the key means of providing protection [5]. On 31 December 2003, the General Sanitary Inspector released an ordinance specifying diseases, syndromes and events, whose occurrence should trigger appropriate early warning systems. The ordinance specified 8 diseases, 3 syndromes and 13 types of events. The list of diseases includes botulism, plague, cholera, smallpox, Q fever, pneumonic and gastrointestinal anthrax, tularaemia and viral haemorrhagic fevers. Among the listed syndromes are:

1) Flaccid symmetric paralyses;
2) Febrile diseases with the signs of respiratory failure, occurring in people travelling from SARS-affected areas within 3 weeks of the return;
3) Febrile diseases with haemorrhagic symptoms with no cause known, especially in people, who returned from abroad during the preceding 3 weeks.

The events listed in the Inspector's ordinance are:

1) Large number of cases of diseases, syndromes and deaths with a similar clinical image occurring at the same time and presenting cutaneous and/or mucosal lesions, as well as symptoms of neurological, respiratory, gastrointestinal or multisystem damage;
2) Rapid, unexpected increase in the incidence and mortality rate of known diseases and syndromes;
3) Occurrence of unidentified diseases and syndromes with a previously unreported clinical image;
4) A single case of a disease caused by a factor usually absent in the local population and occurring in a person, who did not travel abroad in the preceding period;
5) Observed inefficiency of the routine treatment administered in common diseases;
6) Genetically similar etiology of pathogens isolated from sources remote in time and distance;
7) Occurrence of a disease in an unusual period and geographic location;
8) Observation of symptoms atypical for a given pathogen in multiple patients;
9) Occurrence of many foci of food poisoning, expanding beyond one region.
10) Atypical transmission of well-known diseases;
11) Unexplained, epidemic growth of a disease considered endemic;
12) Isolation of an unusual, atypical infection factor, suspected of being genetically modified or obtained from sources considered as inactive;
13) Simultaneous occurrence of foci of similar diseases in nonadjacent areas of the same or different countries.

Several rules may be formed based on the above mentioned guidelines. The main rule presumes that every person exposed to a biological attack should be considered infected. As pathogen transmission needs to be limited, it is necessary to introduce an epidemiological regime at every stage of medical evacuation, transport and care.

## 3. Procedures in the case of biological attack

As stated above, all actions taken in the case of a putative or confirmed act of terrorism using biological weapons of mass destruction should be based on previously established and exercised procedures. Efficient flow of information between the public services involved in rescue operations is essential for effective crisis management [2,4,6]. To this end, apart from implementing a functional communication system, it is vital to develop a coherent set of procedures for all rescue services [7] and related institutions, defining the range of competence of each unit, ways of communication and actions to be taken on a given type of event (involving different procedures for chemical and biological events and for large-scale accidents in road or rail transport).

Plans of protection against bioterrorist attacks should cover e.g. methods of obtaining vaccines, sera and antibiotics, lists of available medical equipment, means of medical transport and distribution of patients in appropriate medical centres [4,8].

## 4. Triage of victims of biological attack

Procedures applied on an event of use of biological weapons of mass destruction, either in an isolated incident or a large-scale terrorist operation, cause rescue services to work under pressure and in extremely difficult conditions. Rescuers, often providing the first-line pre-hospital care, should be aware that their approach to work under biological hazard is different from, for example, that performed under chemical hazard [9].

Segregation of victims under biological hazard is different from that conducted in the case of natural disasters or large-scale transport accidents, but also different from the triage performed in catastrophes caused by other than biological factors [8,11]. In the case of biological hazards, medical segregation depends mainly on how much time has passed from the patient's exposure to the biological agent to the moment of occurrence of general symptoms, including those exhibited by the respiratory and nervous system, toxicoinfections with blood clotting disorders or haemorrhagic fevers.

Population exposed to the risk factor may be divided into five groups:

1) people potentially infected (including those unvaccinated);
2) people infected;
3) people with symptoms and asymptomatic carriers;
4) people, who have been subjected to infection and are not carriers;
5) people, who have been vaccinated [8].

Another classification is based on the course of the disease as a result of exposure to the pathogens used in a bioterrorist attack. The method, which divides the population into four grades characterizing the course of infection, is presented in Table 1.

**Table 1:** Course of a disease induced by a biological agent.

| Grade of the disease | Description |
|---|---|
| Grade I | Mild course, usually in the form of rash or flu-like symptoms, not requiring immediate medical intervention; |
| Grade II | Moderate course in the form of flu-like symptoms and concurrent problems with specific organs; no immediate life threat, however, there is a risk of disease advance, therefore patients require medical attention and evacuation to hospitals or observational epidemiology units; |
| Grade III | Severe course; life threat present, poor prognosis of survival if no specialist treatment (intensive care and therapy) in a multi-profile medical facility is undertaken; |
| Grade IV | Usually poor prognosis due to very severe course; patients require immediate medical rescue to stabilize their vital signs. |

## 5. Disinfection procedures

Disinfection procedures in people exposed to biological warfare agents should be performed as quickly as possible by specialized units (e.g. Biological Defence Battalion of Polish Armed Forces) [10]. All procedures should be performed at level A. According to the rule, that every person present in the area exposed to biological agents is considered potentially infected, every such person has to undergo complete disinfection, while all rescuers providing medical care in that area should be equipped with personal protection measures preventing infection (Figure 1) [11,13,14].

**Figure 1:** Example of an airway protection method.

## 6. Medical evacuation

Efficient medical evacuation of the victims helps to prevent pathogen spreading, i.e. reduces the number of potentially infected people. Poland's accession to NATO resulted in the introduction of both military and civilian universal procedures, applied in all member states. According to the procedure of medical evacuation of biological attack victims (STANAG 2068), three levels of evacuation may be distinguished (levels A,B and C) [15]. Within those three levels, there are four types of rescue *Roles* differing in the level of provided medical care.

Pre-medical care provided by the event witnesses or paramedics is characteristic of *Role 1*. *Role 2* involves more complicated interventions, including: evacuation from "dirty" areas (exposed to biological agents) to "clean" areas, preliminary segregation of victims, disinfection procedures, preliminary medical care and preparation of patients for further evacuation. In the case of impairment of vital signs (circulatory or respiratory failure), medical rescue procedures are applied to restore those functions.

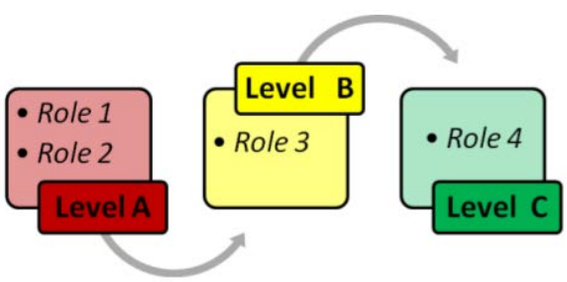


**Figure 2:** Medical evacuation scheme according to STANAG 2068.

*Role 3* comprises observational epidemiology units of stationary hospitals or field hospitals treating infectious diseases. Further patient segregation, application of appropriate therapy and laboratory diagnostics are performed in those units. The Pulawy branch of The General Karol Kaczkowski Military Institute of Hygiene and Epidemiology is an example of a Centre for Diagnostics of Particularly Dangerous Diseases in which specialist tests of potentially infected materials are performed. The facility, satisfying the BSL-3 norm for bacteriological laboratories, was included in the Global Emerging Infections Surveillance and Response System in 2010.Level C (*Role 4*) is characterized by the ability to provide medical care and specialist interventions at the level of both civilian and military clinical hospitals (Figure 2).

## 7. Patient transport

Potentially infected patients constitute a particular group, therefore require particular conditions during transport assisted by medical personnel [11]. Ideally, every patient suspected of being infected should be transported in full isolation from the surrounding environment, which might be provided by ambulances equipped with isolated compartments with HEPA air filters. However, it is not feasible in that case. Ambulances designated for carrying large numbers of potentially infected attack victims should be clearly marked and considered as "dirty" until complete disinfection of the vehicle's interior. This means a complete suspension of such an ambulance from routine duties, managed by emergency medical dispatcher, until disinfection occurs.

Once transported, the patient should be placed in an isolation ward [4,12]. Ideally, in this case, the ward would be equipped with an autonomous ventilation system, an airlock and a decontamination room. If the hospital does not possess such means, negative pressure isolation chambers (NPCs) may be used.

## 8. Conclusions

Training is a necessary, if not the most important element of rescue service preparation for the event of a bioterrorist attack. One needs to remember, that such disasters are often completely unpredictable and local population's assumption, that events like those in New York, Madrid, London or Tokyo may never happen to them, is false. What is more, biological agents used by terrorists are often difficult to detect. Symptoms of the disease may occur after some time, which, combined with atypical and misleading clinical signs during incubation period, complicates the localization of the foci of exposure to biological agents.

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