
The Role and Importance of Forensic Logistics in Reducing the Risk of Contemporary Bioterrorism

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Abstract:

Purpose: The aim of this publication is to analyze the impact of the risk of international bioterrorism on international security based on the forensic logistics model.

Design/Methodology/Approach: Adopted research methods for heuristic cause-and-effect analysis of the risk of bioterrorism on international security based on the forensic logistics model.

Findings: The research problem undertaken was aimed at theoretical application based on heuristic methods of the correlation contained in bioterrorism, as well as in the final solution based on the forensic logistics model. Heuristic cause-and-effect analyzes that are available when weapons are used, should an event occur, while they are active for the security of the entire world.

Practical implications: The results of the deduction of theoretical material based on heuristic methods of research by researchers, which have been verified. On the basis of disease and logical premises, it was indicated that side drugs have a very social and side effect, felt by generations all over the world.

Originality: International terrorism using biological weapons is one of the greatest challenges and threats to the international economy. Progress in biotechnology and genetic engineering allows the development of science and medical research that serves humanity, but at the same time carries the risk of an unequal fight for peace and health in the world. It is a fight for life, health, social well-being and the efficiency of world economies. International terrorism has its own rules, while the elimination of its effects makes this war unequal in the distribution of costs felt by the entire world population. It is necessary to develop international measures to effectively combat manifestations of terrorism. The law is an integral part of the fight against terrorism, prevents discrimination and encourages

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cultural and religious dialogue. Developing common methods of solving conflict situations, equalizing economic opportunities for rich and poor countries with respect for culture and religion, and striving to eliminate poverty in the world is a contribution to further deepening the scientific discussion.

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Paper type: *Research article.*

1. Introduction

Contemporary terrorism is one of the most important challenges of the modern world. On the one hand, the spectacular development of biotechnology, which gives the opportunity to search for vaccines for deadly diseases, and on the other hand, disease control, birth control and analysis of human health. By definition, biotechnology is an interdisciplinary field of science dealing with the change of living and non-living matter through the use of living organisms, their parts or products derived from them, as well as models of biological processes in order to create knowledge, goods and services.

Genetic engineering - conscious and intentional (controlled by humans) interference in the genetic material of organisms in order to change their hereditary properties. Two American biologists, Stanley Cohen and Herbert Boyer, in the early 1970s transferred a human gene to bacteria for the first time, showing that the basic instructions for life are written in all organisms in the same language. This event ushered in the era of genetic engineering.

The low costs of purchasing biological weapons and the possibility of rapid spread carry an irreducible risk to the life and health of the entire world's population. Technological and scientific progress in medicine, logistics and biology creates opportunities to overcome the distance between rich and poor countries, it can be a platform for social dialogue, and in extreme situations, a tool to intensify a conflict taking the form of a terrorist attack (Budowle *et al.* 2007).

The topic of the article is the role and importance of forensic logistics in reducing the risk of bioterrorism in the modern world. The research problem undertaken by the authors can be expressed by the question: To what extent does forensic logistics reduce the risk of bioterrorism in the modern world?

The relevance of the topic of the use of biological weapons in armed or political conflicts undertaken by the authors is becoming a threat to the modern world. As an example, the largest epidemics of the 20th century were cited. About 50 million

people worldwide died from the Spanish flu in 1918–1919, and 2 million people died from the Covid-19 virus (Choi, 2020; Masłowski *et al.*, 2022).

It should be emphasized that acts of terrorism are a kind of rebellion, they are intended to indicate the strength and determination of terrorists in fighting for their goals, as well as to cause anxiety and fear in people, both in those who could stand in the way of achieving these goals, as well as bystanders. A common motive of terrorists is also the desire to attract attention or gain recognition.

The authors raise the topicality of contemporary terrorism using biological weapons. They indicate the essence of the threat to national and international security. They emphasize the special role and importance of logistics in planning and implementing both bioterrorist activities and responses to them, which requires close cooperation between individual state and international bodies and institutions. A forensic logistics model aimed at eliminating events using biological weapons.

It is assumed that it should be an advanced and comprehensive system that would integrate the most important elements of crisis management, criminal prosecution and military and civilian logistics in order to effectively counteract and respond to threats related to bioterrorism. This model covers both prevention and response to incidents involving the use of biological weapons, and its effectiveness is based on a quick and coordinated response, as well as precise tracking and logistical analysis.

Adopted research methods for heuristic cause-and-effect analysis of the risk of bioterrorism on international security based on the forensic logistics model.

The aim of this publication is to analyze the impact of the risk of international bioterrorism on international security based on the forensic logistics model.

2. The Essence of Security and Terrorism

The United Nations Charter is the basic international document in the aspect of international security, which was signed on June 26, 1945 in San Francisco. The provisions contained in the Charter regulate the legal basis for undertaking a joint effort by the international community to eliminate threats to peace and prevent war. "We, the Peoples of the United Nations, determined to unite our forces to maintain international peace and security..." (Velicof, 2020; Brown, 2007).

A sense of security is one of the basic needs and expectations of every person. Security has a social dimension. It is the primary need not only of an individual, but also of a social group. It is also the basic goal of the actions of states and international systems; its absence causes anxiety and a sense of threat" (Brown, 2007).

In essence, security can be understood in two ways: (Masłowski *et al.*, 2022; Masłowski *et al.*, 2024).

- security in the positive sense - active actions of an individual for the sake of security. This is forecasting future threats, prior preparation for their neutralization at the time of their real occurrence, as well as active shaping by the entity of its security and the environment in which it operates,
- security in the negative sense - is understood as a state of absence of threats. In the event of the occurrence of a threat, it assumes the actions of entities.

Security in the positive sense treats threats as real existing events, while security in the negative sense brings with it big problems, subjectivity, and even voluntarism, in defining what constitutes a threat and what does not

They are understood as a lack of something and at the same time encourage the satisfaction and fulfillment of this lack. In his opinion, security, in addition to significant physiological needs, takes a superior place and is understood primarily as freedom from fear. After satisfying it, a person begins to develop other needs, such as love, recognition, respect (Masłowski *et al.*, 2024).

Many countries are struggling with the problem of the development of phenomena that are related to international organized crime, and one of the most dangerous forms of this threat is undoubtedly terrorism. Terrorism is often defined as the use of premeditated violence both collectively and by individual perpetrators on a scale less than national or on a state scale. It is characterized by violence, the threat of violence, with violation of law in order to achieve specific political, economic or social goals.

Terrorism is an inseparable factor of modern life, and its face is very different today. The word "terrorism" literally means terrible news, fear and great fear of something. These feelings often lead to acts of cruelty, violence and even rape. The concept of "terrorism" has its origins and comes from the Latin language, "terror" originally means terrifying news or fear (Masłowski *et al.*, 2024; Pałęga *et al.*, 2023).

From antiquity until the 19th century, the use of force or intimidation was considered the exclusive domain of tyrannical, dictatorial or despotic forms of state power. This situation changed dramatically when anarchist and revolutionary groups made the use of violence the main element of political struggle. At that time, the first wave of terrorism was taking shape, and from then on, assassinations of politicians became an attempt to carry out a revolutionary coup, as well as to arouse social unrest.

Another wave of terrorism appeared in the interwar period, when totalitarian movements began to appear on the historical stage. The third wave of terrorist methods of fighting the state order intensified during the second half of the 1960s,

characterized by leftist extremism and terrorism of Islamic fundamentalists. At the turn of the 20th and 21st centuries, terrorism took on a new meaning, becoming one of the most and fastest growing threats of a transnational nature. This means that terrorist organizations have expanded their reach, operating in many countries and on different continents. In addition, the new generation of terrorists has increasingly started to reach for technological innovations, which poses a huge threat to international security.

They are able to accurately identify critical points, which then become the target of attacks. Equally dangerous is the fact that terrorists are seeking to carry out new types of activities, using chemical, radiological, biological and nuclear means. The ongoing globalization and technological development lead to the internationalization of terrorism, as evidenced by the events of September 11, 2001 (Brown, 2007; Pałęga *et al.*, 2023; Ke and Zhao, 2008).

The terrorist attack that took place in the United States revealed the scale and scope of the impact of terrorism on the international order, and above all on security. As a consequence, all these events led to the beginning of the international "war on terrorism" (Ke and Zhao, 2008).

Maintaining international peace and security is undoubtedly the goal of the United Nations. Many legal regulations have been developed, including protocols or conventions, comprehensively addressing the issue of preventing and combating acts of terrorism. The activities of the UN develop cooperation between states that are associated with the organization in order to build a comprehensive, effective and global counter-terrorism strategy. However, it should be noted that before the terrorist attack on the USA in 2001, the United Nations had a different approach to combating terrorism.

The vision of the emerging threat of terrorism seemed unrealistic and impossible, even for countries that have close relations with the USA, and the threat of attacking other countries was treated only in the category of national threats. For this reason, all possible actions had a mainly political dimension. All UN bodies, in cooperation with each other, create an internally coordinated and specialized system that is intended to combat terrorism. The only way to effectively combat this phenomenon is undoubtedly cooperation and a joint effort undertaken not only by UN bodies, but also by all member states.

Currently, terrorism is characterized by highly precise actions by various organizations, groups and, to a small extent, also by individuals. It occurs as a retaliatory activity that is used against another country. Terrorism is one of the methods of political struggle, it is an asymmetric threat that arises as a result of the activities of various social, religious and ethnic groups. As we know, terrorism knows no borders, and strikes with its destructive power wherever it is least

expected, causing huge losses both moral and material. The shape of current terrorism was influenced by factors such as: (Masłowski *et al.*, 2024; Smokers *et al.*, 2014, Lim *et al.*, 2005).

- dynamic and rapid development of science, culture and technology,
- significant economic and social transformations in countries, as well as in the world,
- the emergence of new social strata and classes,
- visible differences, including differences in the aspirations of social strata and classes on an economic, political and social basis.

The face of terrorism is constantly changing and is encompassing larger and larger areas, not only in terms of territory, but also in the sphere of human life. From a sociological point of view, the concept of terrorism is understood as a manifestation of frustration among certain social groups that cannot find their place in a given social structure. Seeking a cure for this ailment, such groups often resort to violence, which takes away order, security and stability from society (Lim *et al.*, 2005).

There can be many reasons for resorting to acts of terror. These can certainly be economic crises, various types of tensions appearing in society, and even national or social discrimination. Supporters of the socio-economic sources of terror believe that it stems from too large, even excessive, population, economic underdevelopment, ruthless corporate capitalism that draws profits to the West and, importantly, from lack of education. Poverty as well as wealth can be to blame, creating the phenomenon of polarization, a worse and a better world (Lim *et al.*, 2005).

Every terrorist act is characterized by violence or the threat of its use. Terrorism is designed to have far-reaching effects on the human psyche, going beyond the direct victim or the object of the terrorist attack. It is to create power wherever it has not been experienced or to consolidate power that is fragile.

Terrorists desire above all publicity, influence and power that they do not have, in order to carry out political changes both at the local and international level. They are often guided by some ideas for which the value is killing or dying in order to achieve some form of immortality. Almost every person believes more or less in something that goes beyond this earthly life. Unlike animals, they are aware of a later death, which is why people seek something that can distinguish their death from the death of others (Lim *et al.*, 2005; Haas, 2002).

The desire to die for something important, in the name of professed values can give meaning to ordinary life, and these values can cover various areas such as religion, family, ethnicity or nationality. Their determination is so great that they are able to destroy everything in order to show the world their presence and problems. The Internet has proven to be an effective way for terrorists to reach societies.

Terrorists easily disseminate various types of information using websites. They can be used to carry out terrorist attacks all over the globe.

On the Internet, you can obtain knowledge and information that favors terrorist tendencies, including detailed instructions on how to construct a bomb yourself or produce a dangerous weapon, such as chemical weapons. What's more, they use the network to be able to communicate quickly and easily, using information encryption techniques (Lim *et al.*, 2005; Sawa *et al.* 2022).

Current terrorism is characterized by irrationality and unpredictability. It has become an extremely dangerous phenomenon, and the scale of the negative effects caused by terrorist activities of various kinds is proving to be extremely extensive. The real threat of terrorists using weapons of mass destruction has undoubtedly become a serious problem. These are weapons that are generally invisible, impossible to see with the naked eye, and also weapons with great possibilities (Sawa *et al.* 2022).

3. Biological Weapons as Part of ABC/NBC Weapons

Weapons of mass destruction are also called weapons of mass destruction, or ABC and NBC weapons, which are characterized by modern means of combat consisting in destroying living organisms and partially combat equipment, absorbing their range on a mass scale. When describing weapons of mass destruction, the abbreviation ABC weapon stands for atomic, biological and chemical weapons or NBC weapon, meaning nuclear, biological and chemical. Both abbreviations are derived from the first letters of the words that describe them.

Biological weapons are a type of weapon with a combat charge in the form of pathogenic microorganisms, i.e., protozoa, viruses, rickettsiae, bacteria, as well as toxins of biological origin, which are responsible for the development of epidemics in humans and their immediate environment. In addition, germs can also be their natural carriers, who transfer microorganisms directly to humans or to food or water. Pathogens can also be spread by ticks, fleas, mosquitoes, rats, bedbugs, clothes lice, flies, etc. Such procedures led to the uncontrolled development of many epidemics, including plague, anthrax, yellow fever, cholera, and many others (Smokers *et al.*, 2014; Sawa *et al.*, 2022).

The history of using unconventional weapons begins in mythology, or more precisely, before the invention of writing. Knowledge on this subject was passed down from generation to generation. As a result, numerous memories of real and surprising events have survived. According to historical sources, in the 6th century BC, the Assyrians used a grain parasite, ergot, to poison all food for their rivals. At the same time, black hellebore was also used to poison drinking water. In 400 BC, the Scythians poisoned arrowheads with feces and blood from decaying human bodies.

A similar situation occurs with Roman soldiers who, before battle, dipped their swords in manure or the entrails of dead animals (Ke and Zhao, 2008; Skowrońska *et al.*, 2024).

The first recorded use of biological weapons took place in 1346-1347 during the Mongol siege of the Black Sea city of Kaffa. The bustling city of Kaffa, populated by traders from Italian Genoa and numerous merchants, was attacked by the Mongol horde.

In the days before gunpowder or artillery had been invented, it was easier to defend a castle than to capture it. Sieges lasted for months or even years, leading to the spread of various plagues, vermin and, worst of all, epidemics among the forces camped outside the fortress. According to legend, the Mongol army was plagued by the plague, which was impossible to control.

For this reason, the Mongol Khan Janibeg ordered the bodies of the plague victims to be catapulted to Kaffa. As a result of these actions, people who fled by sea to Mediterranean ports quickly spread the disease throughout Europe, dragging fleas and rats infected with the plague with them (Sawa *et al.*, 2022; Skowrońska *et al.*, 2024).

In 1754-1760, during the French-Indian War, British officers Colonel H. Bouquet and General J. Amherst set themselves the goal of eradicating the indigenous inhabitants of North America, implementing a plan that involved giving the Indians clothes and blankets previously used by people infected with smallpox. As a result of these actions, a huge number of Indians died quickly.

Until the 19th century, the use of biological weapons was limited to primitive ways of infecting the enemy with diseases that occur naturally. This research was focused on combating epidemics and strengthened the position of bacteriology, which is a separate scientific field. In the 20th century, however, they were used for other purposes, such as improving methods of conducting biological warfare (Lim *et al.*, 2005; Deisler, 2002).

Since the outbreak of the great world wars, intensive and professional preparations began to be made for the use of biological agents in combat as biological weapons. During World War I, the USA and Germany began to devote special attention to biological weapons, perfecting warfare using them. Additionally, they also developed tactical assumptions consisting of many forms of biological attack.

From 1915, work began on their own cultivation of microorganisms in order to cause dangerous diseases in animals. American doctor Dr. A. Dilger, of German origin, created a biological weapon in his estate in Washington. In order to be able to produce such a weapon, the Government of Imperial Germany provided the scientist with bacterial cultures necessary for the cultivation of glanders and anthrax. Dockers

paid by German agents infected about 3,000 animals with glanders, including horses, mules and cattle, which were sent to Europe for the Allies on the front (Deisler, 2002).

World War II was characterized by the rapid development of bioterrorism. Intensive research on biological weapons began, initiating, among others, anthrax bomb attack in unpopulated areas. Research covered cholera, plague, Q fever and many other microorganisms.

Shortly afterwards, in the 1990s, speculations appeared indicating that terrorists intended to acquire biological and chemical weapons. Long-term research began on offensive biological warfare agents. Work was primarily on agents (Deisler, 2002):

- destroying all cultivated vegetation: wheat rust, rice blight,
- infecting humans: plague, cholera, anthrax, yellow fever, psittacosis, ringworm, typhus and abdominal fever,
- effectively and quickly infecting animals: fowl plague, foot-and-mouth disease and rinderpest, also known as cattle plague.

Since then, bioterrorism has taken on a new meaning, proving to the eyes of the whole world how dangerous it is, becoming one of the most serious threats to modern security, putting societies in the face of a huge threat.

The United Nations definition indicates that among many weapons of mass destruction, those that arouse the greatest fear and suffering should be considered biological. If such substances enter the environment, it can have serious consequences in the form of paralysis of living organisms and infection of the entire environment. In the NATO dictionary of terms and definitions, biological weapons mean "material and technical means that carry, spread or disseminate biological agents, including arthropods. This type of unconventional weapon is characterized by highly destructive power and dynamic development (Yu *et al.*, 2016; Green, 2018).

This weapon is attractive to terrorists due to its ability to hit a large number of people with low logistical requirements. The effect of its use is not noticeable too quickly, and any symptoms appear only from several hours to even several weeks after the agent is used. The possibility of protection in the event of mass use is almost impossible, and contamination can cover every element of the ecosystem.

The most dangerous is considered to be air contamination in the form of an aerosol, as it leads to infection through the respiratory system. In the event of a bioterrorist attack, pathogenic microorganisms are carried and spread over long distances by the wind. Inhaled aerosols containing biological warfare agents lead to the location of dangerous pathogenic particles and toxins in the upper respiratory tract. Through the natural process of breathing, there is a constant supply of the biological agent to the

body. Infection with a biological agent can also occur through the digestive system, contaminating food supplies and water. In such a case, it is important to avoid contact with infected products, which can result in the development of the disease.

Another example of infection with a biological agent is infection through the skin. Undamaged, it is a natural barrier against infection, while the one that has wounds becomes an immediate threat because biological agents easily penetrate the body (Deisler, 2002; Green *et al.*, 2018).

Pathogenic microorganisms during a bioterrorist attack can be transferred by natural forces, an example of this is the wind, terrorists spray them using airplanes, balloons drop them from tall buildings or bridges. Germs can also be their infected natural carriers, who transfer microorganisms directly to people, food or water. What's more, the use of lice, fleas, ticks, flies and mosquitoes is also possible during an attack. In a situation when weapon B is inactive, then it is difficult to detect, and for this reason it is extremely easy to hide and transport.

However, a small portion of these microscopic organisms or biotoxins is enough to be an effective and extremely dangerous weapon. These agents can be very easily sprayed in public places, contaminate water in waterworks and food products manufactured in food factories.

Biological attacks have been divided into four types (Sawa *et al.*, 2022; Green *et al.*, 2018):

- type "P" - involves an attack using various means of delivery, such as artillery shells, bombs, mines, rocket launchers and ballistic missiles;
- type "Q" - causes contamination of distant areas using, ballistic missiles (aerosol generators, air bursts) and ball bombs;
- type "R" - includes attacks where the target is specified but the means of delivery is unknown;
- type "S" - characterizes the detection of a biological agent before the attack is observed.

Biological weapons are made of three elements, which include a means of delivery, an active agent (also called a bio-agent) and a container holding this agent. The means of delivery and dispersion can be rockets, bombs, airplanes, etc. The bio-agents of biological weapons are considered to be viruses, bacteria, rickettsiae, toxins of plant, animal and bacterial origin and fungi.

The container acts as a reservoir for the active agent. Genetically modified microorganisms are particularly dangerous, they are mainly characterized by high mortality, and the production of any medicines takes up to several years. The hallmark of the use of biological weapons is (Green *et al.*, 2018; Wanying *et al.*, 2016):

- a sudden and unexpected increase in the number of deaths and morbidity from unknown diseases,
- the appearance of previously unknown disease symptoms, manifested by changes in the skin, mucous membranes, significant damage to the respiratory system, nervous system or multi-system damage,
- diagnosis of a single case of a disease caused by an exotic factor in an individual who had not left the country,
- an unidentified increase in the number of people suffering from endemic diseases,
- lack of effectiveness in the treatment of diseases that are common and were treated routinely,
- the appearance of simultaneous cases of similar diseases in foci that are not territorially connected in the country or abroad.

Knowledge of the routes of infection with biological agents is essential, as it facilitates rescue operations and facilitates the implementation of various protective or preventive measures. An attack using biological agents can cover a large area, causing a significant increase in the number of diseases in many areas. The dangers resulting from the use of biological weapons are often related to the difficulty of quickly diagnosing the cause of illness and death, recognizing the psychosis of threat in people and the spread of a sense of fear, as well as the intensive spread of many microorganisms, including viruses and bacteria (Wanying *et al.*, 2016).

Ensuring public safety during an attack using biological agents is extremely difficult and depends on many factors. The targets of attacks may include, among others, centers of power, public, critical or economic infrastructure, as well as facilities that, when destroyed, pose a serious threat and huge losses to public safety. The effectiveness of bacteriological weapons depends largely on weather factors.

The wind can uncontrollably carry pathogens. In this way, infecting very distant areas, and even the territory of the aggressor itself. Another factor is humidity; if it is low, the effectiveness of the biological agent decreases. The reason for this is the speed of drying of the agent present in the air. Heavy rainfall is a factor that significantly reduces the level of contamination. This is done by washing out hazardous compounds from the air. It is similar in the case of the action of the sun, the sun's rays are often the cause of the loss of toxic properties of the biological agent (Green *et al.*, 2018; Khan *et al.*, 2019).

4. Forensic Logistics Models

The task of forensic logistics is to analyze the obtained crime scenarios in the field of logistics, in order to use the knowledge thus obtained at a later time, to correctly and effectively identify, analyze and finally stop supply chains used for illegal

purposes. In addition, the knowledge thus obtained would serve the planned counteraction to the creation of such illegal supply chains.

Defining forensic logistics, it is a science that combines the tools, mechanisms of logistics, and uses it to analyze, predict the occurrence of criminal activity, unlawful acts - with imposed sanctions, not only from the point of view of the criminal code, these activities also include evidence that will be provided to the appropriate state authorities (Khan *et al.*, 2019).

The starting point is the science of forensics, namely the committed crime obliges to deduce backwards in order to be able to identify the perpetrator of the event, therefore it is important to determine the optimal courses of action that lead to the crime or to the factors according to which the culprit acted - this is the main goal to achieve. It can be clearly stated that this is inductive thinking, not deductive thinking, but it should be noted that it can be a kind of strategy for solving problems, including solving problems related to crime.

The task of forensic logistics is therefore to analyze crime schedules according to patterns prevailing in logistics, in order to be able to establish a certain chain of repeating activities in the future. The aim of forensic logistics is to identify specific scenarios and answer the question "what if" by drawing up the continuity of certain facts through classical flows of known goods or for supply chains (Wanying *et al.*, 2016; Węgrzyn *et al.*, 2024).

The concept for the discussed logistics is primarily to analyze and develop hypotheses that concern crimes, and in turn, when a crime is detected, the task of forensic logistics will be to determine all possible schedules of prohibited activities.

The developing model of forensic logistics will take the position of collecting and checking case studies of crimes that will be subject to retroactive analysis, in order to obtain all scenarios of events, and at the same time it will be possible to devise a pattern of typical behavior for prohibited activities.

It has been noted that in English-speaking countries, forensic logistics defines: (Khan *et al.*, 2019; Adams *et al.*, 2013).

- "services provided by service and transport companies offering professional forensic equipment and/or transport of traces from the scene of the incident to the laboratory;
- detection and prevention of violations of the law in logistics companies and/or in supply chains;
- detection and prevention of violations of the law in the field of accounting, (document flows);
- forensic logistics can be understood as internal logistics in forensic laboratories or any companies providing services in the area of forensics."

Therefore, specifying the concept of forensic logistics will shape the boundaries between the meanings cited and the created definition, or designating its points of contact with the discussed areas.

In particular, the forensic logistics model should consist of 5 basic elements (Węgrzyn *et al.*, 2024; Adams *et al.*, 2013; Szala and Walczak, 2024):

1. *Prevention and planning* – this is the first and most important element of the forensic logistics model. Its essence is primarily to prevent bioterrorist incidents from occurring. Most incidents involving the use of biological weapons result from deliberate human action, hence intelligence activities should be conducted.

Continuous and systematic monitoring of potential threats is extremely important. In addition, attention should also be paid to collecting intelligence data on criminal groups that may engage in bioterrorist activities. For this purpose, artificial intelligence technology and big data can be used. The task of the planning element is to prepare individuals for real threats. Therefore, a systematic assessment of the risk of bioterrorist incidents should be conducted based on collected intelligence data and analysis of events that have already occurred.

In addition, high-risk areas should also be designated and appropriate preventive measures should be taken, which should focus, for example, on strengthening biological defense. In this respect, it is necessary to indicate the effective protection of biological resources, which can be implemented by conducting constant control and supervision over laboratories working with high-risk pathogens. In addition, constant monitoring of the supply chain of biological materials is also an important task. In terms of protecting human health and life, it is postulated to introduce an appropriate vaccination program for healthcare workers and people exposed to potential bioterrorist attacks.

2. *Early detection and alerting* - this is an element of the forensic logistics model, which occurs at the time of a real threat and is primarily aimed at limiting the effects associated with the occurrence of incidents using biological weapons. In this case, effective early warning systems play an important role. In this respect, it is postulated to build an appropriate biological detection network, which may consist of installing biological sensors in public places (e.g., airports, train stations). Integration of these systems with public health monitoring systems is also important.

An approach based on automatic detection of pathogens should be correlated with the immediate launch of appropriate alarm procedures. In order to limit the spread of the threat and the number of infected people, fast communication (alerting the public) is important. It should be based on a reliable flow of information between health services, government agencies, law enforcement services and the army.

Hence, it is postulated to create centralized communication platforms enabling the exchange of information on existing threats and bioterrorist incidents.

3. Incident response – consists of quick and efficient rescue operations in order to provide assistance to victims and minimize losses and limit secondary damage. In this context, it is assumed that specialized teams will be created that will be able to immediately respond to biological attacks. These teams should be equipped with protective equipment, mobile laboratories and means of transport enabling quick movement to the site of the incident. In addition, it is also necessary to ensure the introduction of effective decontamination procedures in places exposed to biological attacks.

This refers both to the decontamination of areas and the protection of exposed persons. One of the most important actions in the field of response is appropriate logistics management in a crisis. Attention should be paid to, for example, the effective deployment of medical resources, including medicines, vaccines and medical equipment. In addition, it is also necessary to properly plan and implement the evacuation of people from areas at risk in a way that minimizes the risk of further spread of pathogens.

4. Forensic analysis and reconstruction – primarily involves conducting an investigation and forensic analysis, as well as restoring the necessary living conditions and the state from before the crisis. First, effective actions should be taken to secure the scene of the incident and all potential evidence that may help identify the perpetrators. In addition, attacks using biological weapons require detailed laboratory tests on secured samples that can provide information about the pathogen used, methods of its spread and potential sources. Next, attention should be paid to the reconstruction of infrastructure that may have been damaged as a result of the attack, including means of communication and medical infrastructure.

In order to increase resistance to future attacks, it is recommended to conduct a thorough analysis of the attack, as well as identify gaps in the existing system and adapt a preventive strategy.

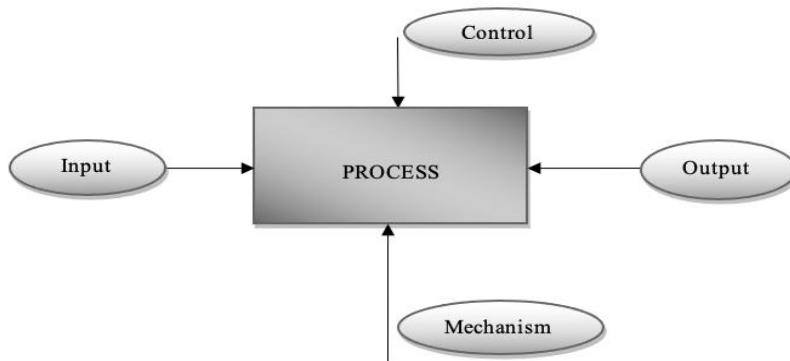
The essence of the article is not to discuss the concept of forensic logistics but to indicate the concept of use based on historical events concerning the use of biological weapons (Binder *et al.*, 2003).

One of the techniques used in logistics for modeling processes and supply chains is the IDEF 0 technique. The IDEF 0 technique was first published by the US Department of Defense in the 1970s, where for many years an appropriate process technique and various methods of obtaining information that would be needed to construct the model were prepared. The IDEF 0 abbreviation stands for Integration DEFinition language 0, where the number 0 denotes one of the IDEF methods series. This method is used for modeling and design, additionally supported by

computer systems "to analyze the state of the organization and plan and manage transformation in various aspects." (Binder *et al.*, 2003; Budowle *et al.*, 2003).

All types of IDEF methods are based on modeling enterprises through: function content, information processing, occurring processes. The combination of graphic elements, i.e. rectangles and arrows creates the so-called ICOM cube, the name comes from the elements it contains: Input, Control, Output, Mechanism.

Figure 3. *Cube ICOM*¹⁰



Source: Budowle *et al.*, 2003.

The cubes created in this way can be connected and used to model processes, they also allow for organizing knowledge about the system's activities and enable work on its further development.

The IDEF0 method is not only a description of processes and information systems, but also the ability to collect data and implement changes. This technique, supported by appropriate IT systems, can contribute to various projects that aim to change processes in economic organizations (Binder *et al.*, 2003; Skowrońska *et al.*, 2024a).

5. Discussion

Protection against weapons B:

Protection against biological weapons is a process of ensuring the safety of people, animals, objects, equipment and weapons. For this purpose, air purification systems are used and the state of threats is systematically monitored. The main tasks of protection against biological contamination include (Skowrońska *et al.*, 2024a):

¹⁰Own elaboration based on A. Burduk, *Modelowanie systemów narzędziem oceny stabilności procesów produkcyjnych*, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 2013, s.62.

- supplying soldiers with preventive measures that allow them to act in the event of contamination,
- equipping the army with individual and collective protection measures,
- carrying out activities related to avoiding threats resulting from the use of biological weapons,
- checking the technical efficiency, i.e. command posts, combat vehicles and medical facilities against contamination,
- providing knowledge to soldiers and preparing them to use individual and collective measures that protect against dangerous contamination,
- training soldiers in the skillful use of the protective properties of their combat equipment as well as the terrain and its entire infrastructure.

Providing soldiers with individual protection measures in the event of contamination is the responsibility of functionaries from the military unit. Each of them receives protective clothing and a gas mask as part of their individual equipment. The conscription takes place immediately after arriving at the military unit.

The persons responsible for preparing soldiers for the safe use of protective equipment are the commanders of the subunits. Under their leadership, numerous training sessions and trainings are organized in the use of protective clothing or gas masks (Skowrońska *et al.*, 2024a; Choi *et al.*, 2016).

Soldiers put on individual protective equipment when the alarm signal about the occurrence of contamination. Standard equipment includes protective clothing, military filters and rubber gloves and footwear, which effectively protect against biological agents. Injured and sick people who are unable to wear protective equipment should remain and be transported in devices designed to protect patients from the effects of dangerous epidemiological or chemical agents.

In the case of collective protection, the army is secured by, among others, hiding places, combat vehicles, field or permanent shelters, and structures and buildings.

Objects that provide protection in the event of a threat should create conditions for (Szcucka-Lasota *et al.*, 2024; Parnell *et al.*, 2009):

- carrying out combat operations by soldiers without the need to reach for individual protection measures,
- maintaining combat capability by the crew, who previously used personal protection measures by providing them with conditions for rest and meeting their physiological needs,
- continuous command of the army - ensuring the possibility of performing the work of communication nodes and command point personnel,
- uninterrupted work of dressing points.

In order to quickly and effectively detect a biological attack, the Global Outbreak Alert and Response system was created, which connects about 70 independent diagnostic and information networks and is based on the most accurate reconstruction of the epidemiological picture. The system uses all incoming information, both from official and unofficial sources. Official sources are the 192 member states of the WHO – World Health Organization and their regional offices (Skowrońska *et al.*, 2024a; Parnell *et al.*, 2009).

Unofficial sources are intelligence networks, which play an important role in the early warning system, often obtaining classified and difficult to obtain information. In a situation where there is no access to information, it is important to be able to spot the signs of a biological attack. Concern should be raised by planes flying at low altitudes, in places where this has not happened before, or when a cloud of fog or a trail of smoke spreads behind the plane. Objects dropped in quite unusual places, such as water bodies, should increase vigilance. In addition, when a large number of rodents and insects appear in an area where they do not normally occur, and symptoms of the disease are visible among domestic animals, it is important not to ignore such signs (Szczucka-Lasota *et al.*, 2024; Parnell *et al.*, 2009)

People who are in places that can be isolated from the outside world, such as their own home, during a biological attack are in a much better situation. Everyday items can be invaluable and essential for survival. These include (Parnell *et al.*, 2009; Skowrońska *et al.*, 2024b):

- a penknife or small knife,
- disinfectants,
- plasters or tapes to secure doors, windows and ventilation openings,
- a battery-powered radio, flashlights (during a biological attack, instructions on how to proceed are transmitted via radio, which are announced by the services appointed for this purpose),
- gloves, e.g. latex, surgical,
- tissues and disposable towels,
- disinfecting soap, etc.

As part of preparations in the event of a biological attack, you should stock up on at least a week's supply of food products, preferably those that do not require cooking, and a large supply of bottled water suitable for drinking. In addition, you should also review the contents of your home medicine cabinet and stock up on all medications that you take regularly, antipyretics, high blood pressure pills, painkillers, etc. People who are prone to stress should think about a large amount of herbal teas or sedatives. The best place to store your food supplies is a basement, previously sealed and disinfected. It is safest to wrap food in cellophane, parchment paper or waxed paper and put it in tin cans with lids or glass jars with caps.

Water should be kept in cans, tightly covered buckets, barrels and pots. Properly preparing your home increases the airtightness of the entire room by about 10-15 times compared to the conditions that prevail outside. The alarm about contamination with biological or chemical agents is broadcast by television stations, radio stations (central and local), broadcasting centers, and also by megaphones that are part of the equipment of some vehicles.

Using sirens, which initially emit an intermittent sound for 3 minutes with the following sequence, 10 seconds of the siren, after a 15-second break, another 10-second siren and a 15-second break. After the alarm is raised, go to a nearby shelter as soon as possible or find a safe place, taking with you the most necessary things prepared for the evacuation. In a situation where you cannot take shelter in a safe place, you should (Skowrońska *et al.*, 2024b; Zaric *et al.*, 2008; Chen *et al.*, 2019):

- button your clothes very carefully, raise your collar, put on gloves and cover your head with a scarf or put on a hat,
- cover your mouth with a scarf or a wet tissue,
- lie on the ground and breathe calmly,
- cover your entire body, e.g. cover yourself with a blanket.

A continuous siren sound that lasts 3 minutes is information that the danger of contamination has been averted and that you should immediately get rid of your clothes and wash your whole body as thoroughly as possible. It is also recommended to disinfect your whole body with a special bactericidal agent.

If you receive a package that arouses concern and suspicion, without the sender's address, name or comes from an unknown sender, do not move or open it. To avoid the threat, you should place it in a bag and seal it tightly, sealing it with tape, then put this bag in a second bag and notify the appropriate services. Once the package has been opened and contains suspicious substances, do not touch, scatter, move, inhale or cause air movement.

In addition, the entire contents of the package should be sealed in a thick plastic bag and sealed tightly. The next step is to wash your hands thoroughly, and the sealed bag should be placed in a second bag and sealed. After completing all activities, it is advisable to wash your hands thoroughly, leave the potentially contaminated area and immediately notify the police station (Szcucka-Lasota *et al.*, 2023).

6. Conclusions

One of the most important premises that can assess the level of bioterrorism threat is the constantly deepening difference between the rich and poor worlds, because it is the cause of many conflicts around the world. Economic stratification leads to constant frustration and social opposition, leading in effect to social revolutions or

terrorism. In addition, the growth of bioterrorist threats is also facilitated by problems of intolerance, fanaticism and nationalism.

In recent years, the threat of bioterrorism has become increasingly greater. For this reason, the perceived danger resulting from the use of weapons of mass destruction influences the taking of specific actions. They mainly consist in eliminating the direct threat associated with the development of weapons of mass destruction on a large scale, but also in effectively counteracting this phenomenon.

As a result, defense against bioterrorism has become one of the priorities of the international community. Issues related to the elimination of bacteriological weapons have been raised many times in the international forum, while each attempt related to this issue was immediately rejected by the United States. Washington's attitude changed after the terrorist attack on September 11, 2011.

In 2001, during the review conference, the issue of the obligations of states was expanded to take into account technological progress in the field of biotechnology. Additionally, special mechanisms for explaining and supervising were launched to investigate the circumstances of suspicious epidemics, and a team was established to provide assistance to victims of biological attacks.

Years of experience indicate that terrorists are able to easily contaminate air, water, food or pharmaceuticals with various types of substances. Large crowds in trains, subways, buildings or airplanes are undoubtedly the target, and modern ventilation systems are becoming the path to distributing biological weapons. In the case of municipal water intakes, contamination turns out to be quite a challenge for terrorists, due to the large amount of water and the operation of filtration processes.

An important goal for a bioterrorist is primarily to cause panic among the civilian population, and the effectiveness of the attack itself is usually of little importance. Terrorists want publicity, which is why individual cases of disease are considered a success. Although there are many different legal conditions for limiting and prohibiting the use of biological weapons, there is still a real threat of using these weapons against the population. In this situation, the international community is constantly modifying and strengthening the already existing legal and international instruments in this area.

The progress that is taking place in the field of biotechnology means that the problem associated with biological weapons and bioterrorism is still relevant and increasingly serious. This is due to the fact that biological weapons do not require large financial outlays and are the cheapest to obtain and produce weapons of mass destruction. There are many reasons for the emergence of threats from bioterrorism.

The first is the era of the Cold War, when satellite states tried to increase their military power by conducting research on bacteriological weapons. Another reason is the lack of proper control of biological weapons. Some countries make the control process difficult by not disclosing their own research or production work.

Technological progress and easy access to components on the market for the production and manufacture of this type of weapon have also contributed to the threats associated with bioterrorism. Currently, it is suspected that about 15 countries that are in possession of biological weapons, including: Russia, Syria, Iraq, Iran, China, Cuba and Lebanon. In addition, the possibility of using biological agents in a terrorist attack has been declared by many groups, such as:

- Basque ETA,
- Al-Qaeda,
- Islamic Resistance Movement-Hamas,
- Right-wing militias from Colombia,
- Front for the Liberation of Palestine,
- Palestinian Jihad,
- Popular Front for the Liberation of Palestine and many others.

The above organizations have repeatedly confirmed the possibility of having dangerous pathogens at their disposal, which are anthrax, botulinum toxin, tularemia, smallpox virus, plague bacilli, etc. They are most often obtained through theft in hospitals or laboratories, purchase of biological agents in one of the prosperous germ repositories or through their own cultivation, deriving them from natural sources.

Biological factors known from experience pose a serious threat to the entire world. According to experts, this threat can be controlled provided that the defense of developed countries is strengthened. However, the greatest concern revolves around significant progress in the field of biotechnology, and above all in genetic engineering.

Analyses conducted so far indicate that the progress of life sciences has at least one element contributing to the development of increasingly better and more dangerous biological weapons.

Examples of directions for the development of such sciences are:

Infectious diseases of animals - crops and farm animals are so-called inbred and homogeneous populations mainly in terms of genetics. For this reason, they are more susceptible to biological weapons that are genetically profiled or classic. The use of this type of weapon is more dangerous than directing it at the human population and can cause tragic socioeconomic consequences. Prion diseases are of great interest because they are resistant to UV and temperature. In addition, they are

easy to produce, stable in the environment, and no reliable test has yet been developed that could diagnose sick animals in real life and distinguish a real attack from a fake one.

Genetic weapons - Through the use of genetic engineering, many biological scientists have already created new forms and types of biological weapons. They are much more effective than their natural counterparts. The idea of this weapon has its origins in biological programs that were created with the intention of fighting between different ethnic groups. The Project Coast program during the apartheid era in South Africa planned to develop bacteria that were intended to deprive black people of fertility. The details of this program have not been fully disclosed.

In the future, it is assumed that data on people susceptible to specific diseases will be available, which will make it possible to design individual drugs, but also to select a homogeneous group in order to hit them with a specially prepared biological weapon. It is also possible that personal databases will be created, to which insurance companies and employers will have access, which may affect employment opportunities or the level of insurance rates for people genetically burdened with the ability to get sick with certain diseases. Worse still, access to such databases may be obtained by people who want to use them for terrorist attacks.

Functional genomics - its guiding principle is the axiom, i.e., one gene. However, cells that are identical in terms of genetics may differ in phenotype and many functions. Defining these functions is one of the properties of functional genomics. Recently, great progress has been made in this field, because in 1997 the possibility of sequencing the DNA code was born, and in 1997, entire genomes. Four years later, the human genome was sequenced, earlier than planned. The National Institute of Health is making the human genome sequence data freely available, which is why some DNA-related techniques may then become cheaper, and production processes may become easy and outsourced. This carries a serious threat because it will expand the transfer of these technologies to those who want to use them to build more effective and improved biological weapons.

Inoculants and biocontrol agents - inoculants are mixtures of many living microorganisms that are added, for example, to seedlings or seeds to accelerate their growth or increase the resistance of crops. In the fight against plant diseases, animal pests or weeds, biocontrol agents are used, which are a living organism or a biologically active substance. These agents can cause undesirable effects, which is why the introduction of GMOs (genetically modified organisms) into the environment is quite strictly regulated. An example of a serious abuse is the Australian viral vaccine, which was used against rodents for contraceptive purposes.

The virus was then modified after introducing the IL-6 gene and began to attack resistant mice. Additionally, in agriculture, an important role is played by methods of proper spraying and aerolysis methods, which are also used for military purposes.

In recent years, these fields have undergone great development, but constant supervision over them is inevitable. The progress of genomics, biotechnology and genetics creates a situation where new environmental challenges appear, i.e. social, ethical and political for much advanced societies. In addition, they cause significant implications for world peace and security, giving the possibility of creating ever newer biological weapons.

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