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Biochemical Terrorism: The Medical Threat in the Twenty-First Century

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September 11, 2001, forever changed the landscape surrounding terrorism. The oceans no longer protected the United States from terrorists. And as incidences in the Philippines, Spain, Iraq, and other corners of the globe have found, no place on the planet can be considered risk-free. Unfortunately, not only must the world be concerned with acts of violence and destruction, but also with the threat of a more insidious nature—chemical and biological terrorism. According to a March 29, 2004, article in the New York Times, the Pentagon released parts of an unclassified document suggesting that the United States is “woefully ill-prepared to detect and respond to a bioterrorist assault.” In this article, our authors offer us a first-hand window into an important and regrettably necessary area of medicine that could affect us both as physicians and citizens in the twenty-first century.

—The Editors

- Many hazardous materials, such as phosgene, cyanide and chlorine, are routinely used in a variety of industries, stored at industrial sites, and readily accessible
- If not detected in the early stages, a disease will rapidly spread throughout the world, creating a global crisis
- Detection of an attack requires recognition of the clinical syndromes associated with the potential agents
- Prompt decontamination must be performed as residual chemical agents may pose a risk for secondary exposure to medical staff in the hospital

Biochemical terrorism—the deliberate dispersion of viruses, bacteria, fungi, and organic or inorganic toxin agents, to kill, mutilate, and create chaos—is a real threat that all countries must cope with today. Both sovereign nations and terror organizations now have the capability to produce and use biochemical agents, and some of them have already demonstrated their eagerness to do so. The development of instant communication has been a further inducement to the terrorists. Each event is reported almost immediately in the media, bringing recognition and reputation to the executors (1–3).

What is the benefit of a biochemical attack? What is the “Extra” that a terrorist group gains by using such weapons? Aside from the enormous damage to life, a biochemical event can undermine an entire society. Its effect on the economy is beyond that caused by a conventional weapon attack. Even a relatively contained attack could lead to the collapse of regimes.

Advances in biotechnology and genetic engineering might confront us in the near future with agents even more infectious, easier to distribute, and resistant to universal treatment.

Although the most significant terror attack, September 11, 2001, did not include biological or chemical components, it was followed by a possibly related distribution of anthrax through the United States mail. Early this year British police uncovered a domestic laboratory producing

ricin toxin designated for use as weaponry (4). In April, osmium tetroxide for use with explosives was discovered, also in Britain. The next attack is just a matter of time.



Modern chemical attacks have been even more ominous than biological ones. The March 1995 terrorist attack in the Tokyo subway with the nerve agent sarin was the largest chemical terror attack to date, resulting in the death of 12 subway passengers. It provoked a growing concern around the world that terrorists could and would use chemical agents against civilian targets (5). As thousands of casualties overwhelmed the medical facilities in the Tokyo area, this incident impressed medical planners everywhere with the necessity of establishing preparedness programs.

The Centers for Disease Control lists the biological agents that can potentially be used in terror attacks (6). The agents are classified into three descending categories, according to the risk they pose to national security. Category A defines the highest priority agents, including *Bacillus anthracis* (anthrax), *variola major* (smallpox), *Yer-*

sinia pestis (plague), and *Clostridium botulinum* toxin (botulism). Category B includes such agents as ricin toxin from *Ricinus communis* (castor beans) and *Staphylococcus enterotoxin B*.

The number of toxic chemical agents that may be used in a terror attack may be even larger. The most toxic agents are the chemical warfare agents, especially organophosphate nerve agents and cyanides. Nerve agents are not readily obtainable, as they are restricted to specific military sites and need special developing and handling capabilities. On the other hand, many hazardous materials, such as phosgene, cyanide, and chlorine, are routinely used in a variety of industries, stored at industrial sites, and readily accessible. The chemicals may be released by means of chemical-containing munitions, atmospheric dispersal, product poisoning, and contamination of food and supplies, thus posing broader threats to public health (7).

Advances in biotechnology and genetic engineering might confront us in the near future with agents even more infectious, easier to distribute, and resistant to universal treatment (8).

Bioterrorism

The modes of bioterrorist attack are diverse, including hoax, food poisoning, aerosol dispersion, and introduction of contagious diseases (1, 2). Historically, the use of fomites, such as contaminated clothing or bodies, was the main technique for spreading disease as a biological weapon. In 1346 the Tatars laid siege to the Black Sea city of Kaffa. When their soldiers began to die of plague, they catapulted the victims' bodies over the walls and into the besieged city. Kaffa's survivors fled by ship to Genoa and Venice. The infected refugees are believed to have initiated the "Black Death" plague epidemic that killed one-third of Europe's population during the 14th and 15th centuries (9).

More recently, the main route of transmission has been the pollution of food and water supplies. In 1984 the Rajneesh religious cult in Oregon contaminated restaurant salad bars with salmonella typhi, leading to the poisoning of 751 people. The aim was to influence local elections (9, 10).

Another infamous bioterrorist attack was the assassination of Georgy Markov, a Bulgarian political exile in London. In 1978, Markov was attacked with a device disguised as an umbrella. He was injected with a tiny pellet of ricin toxin in the umbrella tip (11).

One of the most dreadful scenarios is the covert dispersion of a contagious agent such as smallpox or plague through an air-conditioning system in a crowded area such as a shopping mall (12).

Most biological weapons are not easily spread, but modern life can rapidly hasten infection. Today, there is no need for sophisticated weapons systems like bombs and missiles to terrorize. The idea of sending anthrax spores through the mail system was simple and small scale, yet sufficient to induce widespread panic.

Biological agents cannot be identified by any reliable detection system. Medical staff play a major role in identifying clinical symptoms of infected persons.

If not detected in the early stages of an outbreak, a disease will easily and rapidly cross frontlines and spread throughout the world along the routes of international air travel, creating a global crisis. But globalization provides solutions as well as complications. Such a scenario was played out in the latest worldwide outbreak of a novel disease—severe acute respiratory syndrome (SARS). It originated with a single ill medical worker from Guangdong Province,

China, but infected at least 8,000 persons, killing more than 800 of them. Nevertheless, the SARS outbreak demonstrated the remarkable effects of international cooperation. The new virus was isolated and characterized within a few months and the disease has been contained, although there is no treatment available (13, 14).

Unfortunately, biological agents cannot be identified by any reliable detection system. Medical staff play a major role in identifying clinical symptoms of infected persons. Thus, the detection of an attack requires recognition of the clinical syndromes associated with the potential agents.

Another advance in fighting bioterrorism is the creation of dozens of internet sites offering details about the agents, protective recommendations, treatment guidelines, and other educational material (15).

Another milestone for early detection of outbreaks is an epidemiological surveillance system that provides real-time monitoring of information gathered in the health systems. Such systems are currently under development worldwide.

A bioterrorist attack is expected to be covert and will be revealed, post-factum, after the arrival of the first symptomatic patients following the incubation period of the agent used. In some cases, like smallpox, the incubation period can be up to 2 weeks.

For this reason, Israel, who was over the last decade under the threat of a possible Iraqi missile attack, has constructed multi-disciplinary collaborative teams that are aware of how to deal with such an event, should it occur. The ministry of health led an intensive process to improve the preparedness for a biological warfare event and to minimize its impact once it happened. A supreme steering committee with seven subcommittees was nominated and formulated appropriate doctrines, guidelines and training programs for medical personnel. Clinical protocols include instructions to the medical staff regarding protection, triage criteria, diagnosis and treatment protocols for the diversity of potential agents. Organizational protocols include logistic and administrative instructions. At the early stage of an event, a small number of professionals will act to integrate the response of many individuals and organization, medical and non-medical ministries to ensure a proper response (3,14).

Chemical Terrorism

In contrast to bioterrorism, a chemical terrorist attack is characterized by rapid appearance of symptoms after exposure (minutes to a few hours), and by a circumstantial linkage between the primary release area and the appearance of casualties. Early identification of the event as nonconventional chemical, and detection of the specific chemical agent during the event, is crucial for its effective management. It is also vital for the prevention of casualties among the first responders due to secondary exposure. For example, in the sarin attack on the Tokyo subway, there were 135 casualties among the emergency teams (about 10% of them), as no protective measures were taken before entering the contaminated area.

When the release of a chemical agent is occult, the clinical presentation may be the first, and sometimes the only, indication for the presence of a chemical material (16). There are several characteristic occurrences in a chemical event:

- The presence of a great number of patients appearing with the same clinical picture in a short period of time.
- The presence of symptoms and signs not explained by the mechanism of injury, or the presence of casualties without any apparent cause.
- The appearance of similar symptoms among the first-responders.

Familiarity with typical clinical signs and symptoms of the main chemical agents will allow the first-responders to perform a clinical identification of the agent. The earlier this identification occurs, the better the prognosis of the casualties and the emergency personnel. This fact

emphasizes the importance of education and training of medical staff concerning the medical management of a chemical terror event.

A chemical terror attack poses unique challenges to emergency personnel, both in the management of the event and in the medical response aspects. An adequate response to the incident requires coordination and cooperation of both local and national bodies, including emergency medical services, hazardous material teams, hospitals, the governmental ministry or department of health, civilian and military guard forces, and law enforcement agencies (17).

Other bodies at the national level, such as poison control centers, play a vital role during such an event (18). They can provide crucial information regarding the chemical agent involved, the need for protective gear, and the recommended medical treatment. Preparedness programs are essential and should include several aspects of such an event, including personnel training, provision of protective equipment, means of detection and identification, stockpiling of antidotes, and avenues of decontamination.

The main objectives of the first-responders are to perform basic triage, provide lifesaving medical care, evacuate all the casualties outside the contaminated zone to hospitals, and assess the scene for the presence of ongoing hazards and the need for additional help.

In Israel, these emergency medical teams consist of the civilian Red Magen David, as well as military medical personnel who are in constant preparedness for such an event. The command and control at the scene could be either civilian or the military Homefront Command (equivalent to the U.S. National Guard), depending on the location and dimension of the event. First-responders are responsible for the presence of their protective equipment and have been trained to use them.

Hazardous material teams play a vital role in detecting the agent and in demarcating the contaminated zone as well as decontaminating it (19). If available, decontamination of the casualties is performed in a noncontaminated area as close to the scene as possible. Hospitals located in a clean area are designated to receive the chemical casualties. Patients suffering from medical problems unrelated to the chemical incident are referred to other hospitals, if possible (20).

All exposed individuals receive an initial brief triage, performed by experienced emergency personnel, before decontamination (21). The criteria for performing the triage relate to the possibility of exposure (contaminated/uncontaminated) and severity of injury.

Casualties are then classified as ambulatory (mild cases) or nonambulatory (moderate to severe cases), and are sent to the decontamination site. The hospitals possess partially fixed or preconstructed decontamination facilities that can be activated immediately. Prompt decontamination must be performed as residual chemical agents on those exposed may pose a risk, by contact or evaporation, for secondary exposure to the medical staff inside the hospital. Rapid decontamination also prevents further intoxication of the primary casualties from residual material on their body and clothing.

Medical management of chemical agent casualties should include life support measures, administration of antidotes, and supportive care. In most cases, the use of water and soap will provide effective decontamination. Specific antidotes exist only against nerve agents, cyanide, and lewisite. For other offending agents, treatment is supportive and directed at treating the associated complications (22).

Treatment should be directed also for long-term adverse health effects, which may be caused by a chemical event. Long-term mental health complications may result from the acute psychological stress during the event, or from the intoxication itself (23). After the Tokyo sarin attack, these complications were reported to be significant. Other examples of adverse effects, related to the specific chemical agent, include neurological damage after nerve agent exposure, and chronic pulmonary damage after phosgene exposure. Follow-up clinics should be established as soon as possible after the incident to optimize long-term surveillance and treatment (16).

Conclusion

In the twenty-first century the potential for a large-scale biochemical event has become a reality and poses a challenge for emergency forces all over the world. A non-conventional attack on an unprepared civilian population could become a major catastrophe. It has the potential to defeat all civilian order, health and managing systems bringing chaos and demoralization to the community. It is essential that prompt emergency plans be instituted to cope with this kind of terrorism. Preparedness programs at all medical levels should include staff education as well as acquisition of protective, treatment, and decontamination capabilities. Furthermore, integration and cooperation of all relevant organizations is crucial in case of such an attack (24).

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