BIOTERRORISM, CHEMICAL WEAPONS, AND RADIATION TERRORISM

INTRODUCTION

Large-scale terrorism with biological, chemical, or radiological weapons has yet to happen in the United States. But the 9/11 attack clearly showed that the country could be vulnerable to a determined enemy and because biological, chemical, and (to a lesser degree) radiological weapons do not require enormous technical expertise to develop or use they would be an attractive alternative to use for a terrorist attack. In addition, a terrorist attack using one of these agents would not have to kill many people or produce a large number of casualties to be extremely disruptive. In the United States in 2001, letters containing anthrax spores were mailed to media offices and two United States senators. Five people were killed and 17 were infected, but the incident also created an enormous amount of fear, the investigation required huge amounts of time and money, the cleanup of postal and governmental offices was estimated to have cost over $1 billion, and there were untold number of emergency room visits and countless numbers of calls to health care facilities and public health agencies.

The use of biological and chemical weapons for warfare dates back many centuries, and it has continued up to the present. The use of biological, chemical, or radiological weapons for the purposes of terror is also very old, but there are important differences between warfare and terrorism. Terrorism can be defined as a deliberate act of violence that is intended to cause harm but to also make a political or ideological statement, so the use of these non-traditional weapons for terror would be likely to occur outside of the context of an obvious, declared armed conflict and the targets would not be military but civilian. The Aum Shinrikyo cult in Japan made several unsuccessful attempts to spread anthrax and botulinum toxin into the civilian population before they released sarin (a nerve agent also known as GB) into the Tokyo Metro subway system in 1995. The Rajneeshees, a religious cult based in Oregon, used Salmonella typhurium to contaminate salad bars at local restaurants in 1984, and the anthrax attacks in the United States were already discussed.

Terrorism using biological, chemical, or radiological weapons has happened, it will happen again, and it will probably happen in the United States. Preparing for a terrorism attack can seem daunting. Very, very few people have practical experience and/or a good working knowledge of biological, chemical, and radiological weapons: until recently there has been no need to have either. However, although the likelihood of a terrorist attack is remote, there is potential for serious harm to patients and health care personnel if a terrorist incident is not handled competently.
OBJECTIVES

When the student has finished this module, she/he will be able to:

1. Demonstrate familiarity with acts of terrorism and weapons of mass destruction.
2. Demonstrate familiarity with personal protective equipment required for acts of terrorism.
3. Be able to identify common symptoms and methods of treatment associated with exposure to, or injuries caused by, chemical, biological, radioactive and nuclear agents.
4. Demonstrate familiarity with syndromic surveillance and reporting procedures for acts of terrorism that involve biological agents.
5. Demonstrate familiarity with the information available on, and the use of, the Health Alert Network.

BIOTERRORISM

Biological warfare is described as the intentional use of microorganisms or toxins derived from living organisms to cause death, disability, or damage. In the wake of the September 11, 2001 terrorist attack on the United States, the possibility that another such disaster could take place using radiological, chemical, and/or biological weapons has been a prominent part of the national consciousness. Biological weapons in particular are terrifying, perhaps because they can act in unseen and insidious ways. They are also frightening because there can be a delay between exposure and the onset of signs and symptoms; the victim may not know he/she has been exposed until hours or days later, at which point it may be too late for effective treatment.

For many people, biological, chemical, and radiological weapons are considered more or less the same – diabolical, deadly, and extremely dangerous – but although these weapons can all, potentially, inflict tremendous harm, in many important ways they are quite different. Biological weapons have unique characteristics.

- Biological weapons are attractive from the standpoint of a terrorist because they are relatively easy and inexpensive to produce. Countries that are making biological weapons can also more easily hide the production.
- To successfully make a microorganism a weapon, it must be purified, made to the proper size, stabilized, and put into a form that can easily be disseminated. Each of the biological warfare weapons has specific production requirements: experience has shown that freeze drying and then encapsulating is a commonly used method.
• Biological weapons would not usually require sophisticated, expensive, and difficult to hide delivery systems.
• Small quantities can have an enormous impact.
• Compared to chemical or radiological weapons, biological weapons could be easily disseminated.
• Chemical weapons are manufactured from available industrial materials; biological weapons are derived from naturally occurring organisms such as viruses or bacteria or from toxins that are produced by living organisms.
• The effects of biological weapons are identical to, or closely mimic, the syndromes caused by naturally occurring organisms or toxins when people are exposed to them in the natural environment, and these effects may mimic naturally occurring diseases; the effects of chemical weapons are often odd and unique. As a result, an attack with a biological weapon may be difficult to detect and diagnose.
• The biological agents are (with the exception of mycotoxins which are not covered in this module) not dermally active or absorbed and none are naturally volatile, and these facts have a significance in terms of how biological weapons could/would be deployed.
• Biologic warfare agents often produce illnesses that are characterized by an incubation period, while chemical agents and radiological weapons (usually) cause immediate harm. This has significance because it may be difficult to link an attack or a suspicious incident that occurred days or weeks prior to a patient’s complaints.
• There has been limited success with the use of biological weapons and far less experience with them as weapons than there has been with chemical weapons. However, the technical difficulties involved in using biological weapons effectively may one day be solved and a serious attack could occur.

Biological weapons do have disadvantages. They can affect the health of those who produce them or who use them during an attack. Unlike explosives, they require advanced technology to produce, many are not stable in the environment (e.g., plague), and weather conditions can affect the dispersion. However, given the right circumstances, a biological weapon could do enormous harm. The municipal water supply of Milwaukee was accidentally contaminated with cryptosporidiosis in 1993 and more than 1/3 of the population – 430,000 people – became ill. This was not the result of terrorism, but it illustrates how enormous harm could be done by intentional contamination with a pathogen. It has been estimated that 10 grams of anthrax spores has the potential to cause as much harm as a ton of sarin nerve gas. A small airplane with an aerosol generator could spread 100 kg of anthrax over a 3 km² area: with the right wind and weather conditions, this could cause 3 million deaths. Of course, that supposes that quantity of anthrax could be produced and transported without being detected, flown over a densely populated area without being challenged, and that the wind and weather conditions would be just right for the amount of time needed for the attack to be carried out. And when anthrax was found in the mail system in 2001, there were five deaths from inhalational anthrax and 17 other cases of inhalational and cutaneous anthrax. The actual toll in terms of morbidity and mortality was quite small, but consider how disruptive and taxing this
incident was: there was an enormous cleanup effort of government buildings, untold number of emergency room visits, huge numbers of calls to health care facilities and public health agencies, over one million bio-analytical tests on over 125,000 samples sent to the CDC, an immeasurable amount of public anxiety and fear, and millions of dollars spent.

**HISTORY OF BIOTERRORISM**

Bioterrorism is as old as civilization and has been a constant in the history of warfare and human aggression. During the twelfth to the fifteenth century BC, the Hittites intentionally released infected animals into the territory of their foes, hoping to cause illness, and there have been many historical reports of diseased prostitutes being sent to cities or army encampments in an attempt to incapacitate citizens or soldiers. The ancient Tatars took cadavers of people who died from plague and catapulted them into cities they had under siege, hoping to start an epidemic. Beehives and jars filled with poisonous snakes and scorpions have been hurled at opposing armies, armies have used artillery shells filled with the saliva from rabid dogs, and blankets infested with smallpox were distributed to Native Americans during the 18th century; in the history of armed, organized human conflict, almost anything that was considered poisonous has been used in one way or another as a weapon. The most recent, documented use of biological agents as an offensive weapon during war time was by the Japanese during World War II. The infamous Unit 731 – a branch of the Japanese army that was involved in developing and testing biological and chemical weapons – used plague, cholera, anthrax, salmonella, and other infectious agents against the Chinese, the Soviets, and some Allied prisoners and civilians; at one point, 15 million fleas infected with plague were dropped from aircraft onto Chinese cities.

But although biological weapons have not been used during formally declared wars for almost 70 years (chemical weapons were definitely used in warfare during the 1980s and the 1990s, and there are strong yet unconfirmed suspicions that mycotoxins – a toxin produced by fungi – were used in Laos, Kumpachea, and Afghanistan during 1975 to 1983), they are still with us today. The Aum Shinrikyo cult in Japan made several unsuccessful attempts to spread anthrax and botulinum toxin before they released sarin (a nerve agent also known as GB) into the Tokyo Metro subway system in 1995. Another cult, the Rajneeshees, based in Oregon, used *Salmonella typhurium* to contaminate salad bars at local restaurants in 1984. In 2001, anthrax spores were mailed around the United States, causing at least 5 deaths, and ricin was found in Washington DC in 2004. Most nations have stopped producing biological weapons, and many have destroyed the ones they once had. But there is always the possibility that more can be made, and China, Iran, Iraq, North Korea, Syria, and other countries are strongly suspected of continuing to develop and stockpile biological weapons: Iraq admitted that it had produced 19,000 liters of botulinum toxin during the first Gulf War. If there is a deadly microbial illness anywhere in the world, there is the potential for it to be developed and used as a weapon.
CLASSIFICATION OF BIOLOGICAL WEAPONS

The Centers for Disease Control and Prevention has developed a classification system for biological agents. Each agent is categorized according to the following:

- Ease of dissemination
- Mortality rates
- Potential to induce public panic
- Special procedures required for identification and management

The Categories are in descending order of seriousness, A, B, and C.

- Category A agents include anthrax, botulism, plague, smallpox, tularemia, and viral hemorrhagic fevers, e.g., Ebola, Marburg, Lassa, etc.
- Category B agents include brucellosis, epsilon toxin of clostridium perfringens, food threats such as salmonella, shigella, etc., glanders, melioidosis, psittacosis, Q fever, ricin toxin, staphylococcal enterotoxin B, typhus fever, viral encephalitis, and water safety threats, e.g., Vibrio cholerae.
- Category C agents include Nipah virus and hantavirus.

Anthrax

*Bacillus anthracis* is a bacterium. The name anthrax comes from the Greek word *anthrakis* which means coal; people with cutaneous anthrax typically have ulcers that develop black eschar. *B. anthracis* is a gram-positive, aerobic, and non-motile bacillus that is found in soil all over the world. During certain environmental conditions or when there is a lack of nutrients, the bacterium will transform into extremely small spores. (Note: A spore is a dormant, metabolically inactive form of bacteria) Given the right conditions, the spores can revert to an active bacillus.

Anthrax infection is almost always caused by exposure to the spores, and it occurs by inhalational, cutaneous, and gastrointestinal routes. Anthrax is easily available, it is stable when made into an aerosol, it has a high infection to illness ratio, and there is a high fatality rate for inhalational anthrax. It is unlikely that the dermal or gastrointestinal routes would be chosen for bioterrorism.

Inhalational Anthrax

This is the most dangerous form of anthrax infection. Only a very tiny amount of anthrax spores – perhaps as few as three – is required to cause an infection, and the dose needed to kill 50% of the people infected (commonly called the LD₅₀) ranges from 2500 to 55,000 spores. Given the fact that the spores are only 1-5μm micrometers (a micrometer is one millionth of a meter) and a human hair is 100 μm, it is obvious that anthrax spores can be easily concealed and transported.

Because of their small size anthrax spores are easily inhaled and quickly reach the alveoli. Once they reach that point they are absorbed by macrophages and transported to
the lymph nodes of the pulmonary hilum and mediastinum. The spores then germinate into rapidly replicating active bacteria that have a protective capsule that makes them very resistant to phagocytosis. The bacteria produce three toxins that cause extensive tissue damage.

- **Signs and symptoms:** Fever, cough, malaise, respiratory distress, cyanosis. *The initial phase of an anthrax infection produces a non-specific clinical picture similar to an influenza infection.*
- **Incubation period:** One to six days, but occasionally much longer.
- **Anthrax as a biological weapon:** Aerosol, powder, or any form that could be inhaled.
- **Mode of transmission:** Inhalation. Anthrax is not spread person-to-person.
- **Cause of death:** Septicemia, meningitis, hemorrhagic mediastinitis, respiratory failure.
- **Mortality rate:** As high as 85% in untreated cases.
- **Diagnosis:** Identification of *B. anthracis* in the blood or tissues (Note: Samples must be taken before antibiotics are started.), mediastinal widening as seen on chest x-ray or CT scan.
- **Treatment:** Ciprofloxacin, doxycycline, penicillin plus streptomycin, and anthrax vaccine. (Note: The use of the anthrax vaccine for post-exposure case is not FDA-approved, but medical authorities have concluded it is effective and should be used in these situations).
- **Prophylaxis of exposed, asymptomatic patients:** Ciprofloxacin, doxycycline, or levofloxacin for adults. The antibiotics must be taken for 60 days.
- **Preventative treatment and vaccination:** See above. An anthrax vaccine is available.

**Learning Break:** *Person to person transmission of inhalational anthrax does not occur.* Airborne precautions are not needed and standard barrier precautions are all that are needed.

**Learning Break:** *The key to effective treatment of an anthrax infection is early recognition.*

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**Yersinia Pestis – Plague**

The plague (also known as bubonic plague or the Black Death) is an illness caused by *Y. pestis*, a gram-negative bacterium. There are three forms of plague: bubonic, septicemic, and pneumonic. In nature, plague is a disease that is found in rodents and spread to humans by fleas that have bitten an infected animal and then bite a human host. The three forms of plague differ in important ways, but plague is a disease that has a short incubation period, a rapid onset of symptoms, and a high mortality rate if it is not treated.

*Y. pestis* produces a strong inflammatory response, and it also produces toxins that cause destruction of tissues and multi-system organ failure. Bubonic plague is the most common form and accounts for approximately 85% of all cases. Septicemic plague
occurs when there is a systemic infection without lymph node involvement, and it can be a complication of bubonic or pneumonic plague or it can occur by itself. Bubonic and septicemic plagues are initially contracted through insect bites or by transmission of *Y. pestis* through breaks in the skin, and these forms of plague are not spread from person to person. Given these facts, it is very unlikely that people who have bubonic or septicemic plague are the victims of a biological weapon attack, and these forms of plague will not be covered in detail.

Pneumonic plague, however, is contracted by inhalation of infected airborne droplets (although some patients with bubonic or septicemic plague can develop pneumonic plague), it can be spread from person to person, and there is no doubt that some countries have developed biological weapon containing plague in the form of an aerosol.

- **Signs and symptoms:** Fever, cough, chest pain, respiratory distress, hemoptysis, and gastrointestinal distress. **Onset is abrupt.** Some clinicians recommend looking for the three Hs of hemoptysis, hematemesis, and hemorrhagic diarrhea.
- **Incubation period:** One to six days.
- **Plague as a biological weapon:** Aerosolized vapor.
- **Mode of transmission:** Inhalation. Pneumonic plague can be spread from person to person.
- **Cause of death:** Respiratory failure, shock, disseminated intravascular coagulation, gram-negative sepsis.
- **Mortality rate:** If pneumonic plague is not diagnosed within 24 hours, the mortality rate has been reported to be as high as 50% in untreated patients.
- **Diagnosis:** Usually based on exposure history, clinical findings, and sputum, throat swab, and/or bronchial washing cultures.
- **Treatment:** For individual patients with a confirmed diagnosis, streptomycin or gentamycin are the antibiotics of choice. In a mass casualty incident in which it would be impractical to deliver parenteral antibiotics to large numbers of patients, doxycycline or ciprofloxacin are recommended. People who have been exposed to the bacterium and have a fever or cough should be treated with doxycycline.
- **Prophylaxis of exposed, asymptomatic patients:** People who may have been exposed to the bacterium or people who have been in close contact (less than two meters) to people with untreated pneumonic plague should be treated with doxycycline.
- **Preventative treatment and vaccination:** See above. There is no commercially available plague vaccine.

**Learning Break:** Patients with pneumonic plague should be isolated until they have received 48 hours of antibiotics.

**Learning Break:** Respiratory precautions must be used by staff who caring for a patient with pneumonic plague. As the plague bacterium does not survive for long (an hour or so) outside of a host, no special precautions are needed to clean areas or linen/clothing: standard precautions are sufficient.
Botulism

_Clostridium botulinum_ is an anaerobic, gram-positive, naturally occurring bacterium that forms spores, and the neurotoxin that these spores produce – botulinum toxin – is the most lethal known biological substance. The median LD$_{50}$ of botulinum toxin is 1 ng/kg (e.g., 0.007 mg in an average 70 kg man), so an amount as small as 0.05 to 0.1 μg can cause death. There are 8 serotypes of botulism, A, B, C1, C2, D, E, F, and G; types A, B, and E cause botulism in humans. The botulinum toxin acts at neuromuscular junctions, postganglionic parasympathetic nerve endings, and peripheral ganglia, binding irreversibly at these sites and preventing the release of acetylcholine.

_C. botulinum_ is found in soil everywhere and it can be easily isolated and removed. There are six different types of botulism: food-borne, infant, wound, adult-intestinal, inadvertent (occurring when there is misuse of botulinum toxin during medical procedures), and inhalational botulism. Of these six, inhalation and food-borne would be the most likely forms to be used biological weapons. Little is known about inhalation botulism because it is not a naturally occurring form of the disease; there are only three known cases of human inhalational botulism and these happened to veterinary workers.

- Signs and Symptoms: Botulism – food-borne or inhalational – is characterized by three classic signs, a) a symmetric, descending paralysis, b) the patient is afebrile, and c) the patient has a clear sensorium. Patients also frequently have the “4 Ds” of diplopia, dysarthria, dysphonia, and dysphagia, and also bulbar palsies (Bulbar palsies are caused by impairment of the cranial nerves XI, X, XI, and XII).
- Incubation period: The usual incubation period for food-borne botulism is from one to five days, but this can vary widely: cases have been reported as soon as two hours after exposure and as long as eight days after exposure. The incubation period of inhalational botulism is not known.
- Botulinum toxin as a biological weapon: Aerosol or food contaminant. It is unlikely that public water supplies could be contaminated because of technical difficulties and because the botulinum toxin is quickly inactivated by the standard public water treatment methods of chlorination and aeration.
- Mode of transmission: Inhalation, ingestion. Botulism is not transmitted person-to-person.
- Cause of death: Respiratory failure.
- Mortality rate: Not really known for airborne botulism. The food-borne botulism mortality rate has been reported to be 5 to 10%.
- Diagnosis: Initially this is made clinically. Confirmatory testing of serum, stool, contaminated food, etc. requires a specialized laboratory. _Botulism can easily be mistaken for myasthenia gravis or a variant of the Guillain-Barre syndrome._
- Treatment: Early and aggressive support of the patient’s pulmonary function is critical. Botulism anti-toxin neutralizes circulating toxin and works against the serotypes A, B, and E. It does not reverse paralysis. _Treatment should not be delayed for laboratory confirmation._ There is an anti-toxin that can be used for treatment of A-E botulism, but it is not easily available.
• Prophylaxis of exposed, asymptomatic patients: This is controversial. There is no evidence to support its use in these cases, but there is no evidence against its use.

• Preventative treatment and vaccination: There is no vaccine for botulism.

**Learning Break:** One vial of botulinum antitoxin provides between 5500 and 8500 IU of each type-specific antitoxin. The amount of neutralizing antibody in both the licensed and the investigational equine antitoxins far exceeds the highest serum toxin levels found in foodborne botulism patients, and additional doses are usually not required.

**Learning Break:** Botulism is not passed from person to person: standard precautions can be used. Botulinum toxin does not pass through intact skin.

**Learning Break:** Botulinum toxin is easily destroyed. Heating food or liquids to an internal temperature of 85°C for at least five minutes is sufficient to make them safe. Clothing and skin should be washed with soap and water and surfaces can be wiped down with a solution of 0.1% hypochlorite bleach solution.

**Smallpox**

Smallpox was once one of the scourges of mankind and for thousands of years was the leading cause of infection-related death, but the last recorded case in the United States was in 1949, the last case reported was in Somalia in 1977, and in 1981 the World Health Organization declared that the disease had been eradicated. There are two main types of smallpox caused by the virus: variola major, accounting for approximately 90% of all cases, and variola minor. Variola major is further divided into four types: ordinary, modified, flat and hemorrhagic. The flat and hemorrhagic are the most dangerous.

• Signs and symptoms: In the initial phase of the illness high fever, malaise, headaches, body aches, and vomiting are seen and people may (but may not be) contagious during this time. After this prodromal phase of 2 to 4 days, patients develop a rash in and around the mouth and then the rash spreads through the body. The areas of rash become raised pustules and after a period of time these scab over and eventually the scabs fall off, leaving the characteristic smallpox scars.

• Incubation period: 12 to 14 days, but can range from 7 to 17 days. People are not contagious during this period.

• Smallpox as a biological weapon: Aerosolized vapor.

• Mode of transmission: Inhalation. Direct and fairly prolonged face-to-face contact is required for smallpox to spread from person to person. Body fluids can also spread the disease.

• Cause of death: Septicemia.

• Mortality rate: Mortality rate: Untreated smallpox (variola major) has a mortality rate that has been estimated to be 30% to 50%. The flat and hemorrhagic forms are much worse, and the hemorrhagic form is almost uniformly fatal.

• Diagnosis: Characteristic signs and symptoms, and isolation of the smallpox virus from a clinical specimen and PCR identification of smallpox DNA.
• Treatment: Symptomatic/supportive care; there is no specific treatment for smallpox
• Prophylaxis of exposed, asymptomatic patients: Vaccination; see below.
• Preventative treatment and vaccination: Vaccination within three days, if the patient has been exposed but has no signs or symptoms, will greatly reduce or completely prevent signs and symptoms.

Learning Break: Patients are most contagious during the 7 to 10 days after the rash appears. Once the scabs fall off, they are not contagious. **Respiratory precautions should be used; the patient should be isolated until all scabs fall off.** The isolation room should have negative air pressure and a HEPA filter. Personnel entering the room should wear gowns, gloves, shoe covers, eyewear and an N95 respirator mask. (Note: An N95 respirator is a tightly fitted mask – similar to a surgical mask – that filters out much smaller particles and is much more effective at preventing transmission of respiratory particles from an infected person to others. Ordinary surgical masks are ineffective in these situations)

Learning Break: Smallpox can be differentiated from chicken pox by the pattern of the pustules. In smallpox, these are seen on the palms of the hands, the soles of the feet, and on the arms and hands. In chicken pox, they are mostly seen on the torso.

Learning Break: This is considered one of the most dangerous biological weapons because it is easily transmitted from person to person, very few people today are immune, and there is no highly effective therapy.

**Tularemia**

Tularemia is a disease cause by an aerobic, gram-negative coccobacillus called *Francisella tularensis*. Tularemia is a widespread disease among many species of wildlife, and it is spread most often to humans by the bite of ticks that have been feeding on infected animals. It can also be contracted by drinking contaminated water, by inhalation, or by ingesting contaminated soil. There is a long history of attempts to develop the tularemia bacillus as a biological weapon, but it is unclear if it has ever actually been used in this context. However, tularemia is widespread, the organism would be easy to aerosolize, it is highly infective (only small number of organisms are needed to cause the disease), and it has been developed as a biological weapon so it must be considered as a potential threat. There are distinct forms of tularemia, but there is a lot of similarity in the clinical presentation between them. **Ulceroglandular:** this is the most common form. It is spread by entry of the organism through a break in the skin (usually by an insect bite) and usually produces local signs and symptoms. **Pneumonic:** this is spread through inhalation and produces pulmonary findings. **Typhoidal:** also called septicemic tularemia, this form often does not have a readily found inoculation point and produces systemic signs and symptoms. There are other forms of tularemia, but they will not be discussed here. The most likely form of tularemia that would be seen if the organism was used as a biological weapon would be pneumonic. However, pneumonic
tularemia can be a complication of both ulceroglandular and typhoidal forms of the disease.

- Signs and symptoms: Dry cough, respiratory distress, fever, and pleuritic chest pain.
- Incubation period: Usually three to five days, but the range has been reported to be 1 to 21 days.
- *Francisella tularensis* as a biological weapon: This would almost certainly be in the form of an aerosol.
- Mode of transmission: Inhalation. There is no evidence of person-to-person transmission.
- Cause of death: Respiratory failure or one of the complications of tularemia which include percarditis, peritonitis, or meningitis, lung abscess, or septic shock.
- Mortality rate: This depends in part on the form of the disease. In patients with ulceroglandular tularemia who receive timely and appropriate treatment, the mortality rate is approximately 1%. In untreated cases the mortality rate is approximately 5% and in cases of pneumonic or typhoidal tularemia the mortality rate can be as high as 30%.
- Diagnosis: Tularemia is considered to be a Class A biological weapon because pneumonic tularemia has a high mortality rate, and tularemia is a difficult disease to diagnose. The only reliable way to diagnose tularemia is with serologic testing to detect antibodies. Other laboratory studies are only helpful in excluding the presence of other diseases, and the findings seen on chest radiographic studies are non-specific.
- Treatment: Streptomycin is the antibiotic of choice. Gentamycin and chloramphenicol are acceptable alternatives. When there are mass exposures, tetracyclines or fluroquinolones would be appropriate. Antibiotics should be used, depending on the drug, for 7 to 14 days.
- Prophylaxis of exposed, asymptomatic people: Oral antibiotics should be given for 14 days, along with close medical monitoring.
- Preventative treatment and vaccination: There is a vaccine that has been used for tularemia, but it is currently under investigation and not easily available.

**Viral Hemorrhagic Fevers**

Viral hemorrhagic febrile illnesses are caused by a group of RNA viruses (Note: An RNA virus is a virus that has RNA as the core of its genetic material). There are four families of these viruses and at least 11 different diseases they can cause. Some of these diseases, e.g., Ebola, dengue, Lassa fever, Marburg, are infamous, and they can be highly infectious, rapidly fatal, and have a very high mortality rate. The viral hemorrhagic fevers cause a clinical picture that is most prominently characterized by vascular permeability and platelet dysfunction which leads to widespread bleeding and shock and multi-system organ failure. The mode of transmission is different for each virus, and is not completely understood for the most feared, Ebola. However, it is safe to assume that these viruses can be spread by inhalation, blood, breaks in the skin, and possibly by ingestion.
• Signs and symptoms: These vary somewhat depending on the infecting agent, but fever, malaise, vomiting, and widespread bleeding are commonly seen. Petechiae and ecchymoses are common.

• Incubation period: Varies depending on the virus, but can be short (two to five days for dengue) or relatively long. The most dangerous – Ebola and Marburg – have incubation periods of 3 to 16 days.

• Viral hemorrhagic fever viruses as biological weapons: These have never been used as weapons, but most likely an aerosolized form of the virus would be the mode of choice.

• Mode of transmission: Inhalation. Person-to-person transmission can occur.

• Cause of death: Bleeding and shock, multi-system organ failure.

• Mortality rate: Ebola and Marburg essentially kill everyone who is infected. Some of the other viral hemorrhagic fever viruses are much less toxic. Dengue fever is very common and the mortality rate can be as low as 1% with aggressive supportive care.

• Diagnosis: Serologic tests are definitive.

• Treatment: There is no specific treatment for the viral hemorrhagic febrile illnesses, although ribavirin has been successfully used to treat Lassa fever. Treatment is supportive and symptomatic.

• Prophylaxis of exposed, asymptomatic people: Not applicable.

• Preventative treatment and vaccination: There are vaccines available for some of the viral hemorrhagic febrile illnesses.

Learning Break: Extreme caution should be used when caring for a patient who is suspected to have a viral hemorrhagic fever. Recommendations for personal protective equipment vary, but double gloves, impermeable gowns, face shields or goggles, and leg and shoe coverings should be used.

**CATEGORY B AGENTS**

These biological weapons would be moderately toxic, relatively easy to disseminate, would have a low mortality rate, and they would be used not primarily to kill but to spread panic and confusion. Many of microorganisms listed here are the causes of common zoonotic diseases, diseases that are naturally occurring in animals.

**Brucellosis**

The *brucella* bacteri are gram-negative, aerobic, non-motile and do not form spores. It is a common organism found worldwide. It is often infects animals and there are four species, one that infect goats and sheep (*brucella melitensis*), one that infects swine (*brucella suis*), one that infects cattle (*brucella abortus*), and one that infects dogs and coyotes (*brucella canis*). Humans can contract brucellosis by eating unsterilized meat or milk or coming into contact with secretions from animals infected with *brucella*. The organism is highly contagious, but the disease in quite uncommon in the United States.
• Signs and symptoms: Fever, gastrointestinal problems, cough, and pleuritic chest pain.
• Incubation period: 2 to 4 weeks.
• Brucecella as a biological weapon: Aerosolized vapor.
• Mode of transmission: Through abraded skin, ingestion, and inhalation of aerosolized bacteria. Person-to-person transmission, if it occurs, is very uncommon.
• Cause of death: The disease is rarely fatal. If death occurs it is usually due to endocarditis. Significant complications can occur and some are relatively common and serious, e.g., osteoarthritis, endocarditis, orchitis, and meningitis.
• Mortality rate: Less than 5% of untreated cases.
• Diagnosis: Serologic testing and cultures.
• Treatment: Doxycycline and rifampin for at least 6 weeks.
• Prophylaxis of exposed, asymptomatic people: Not recommended unless exposure is highly likely.
• Preventative treatment and vaccination: There is no vaccine.

Learning Break: Any surface contamination can be handled using 0.5% hypochlorite. Standard precautions are recommended. Respiratory precautions are not needed except for laboratory workers handling specimens.

Clostridium Perfringens Epsilon Toxin

*Clostridium perfringens* is a gram-positive, anaerobic, spore-forming bacterium. It is found in soil virtually everywhere and it is also found in the gastrointestinal tract of humans and animals. The *clostridium* bacteria produce 12 different protein toxins, and the epsilon toxin is of interest as a category B biological weapon because it is very potent, and it is produced by clostridium strains not normally found in humans. Although *clostridium* infections such as clostridial food poisoning and gas gangrene are well known, there is essentially no experience with clostridium epsilon toxin infections contracted by inhalation of an aerosol, so it is not clear how it could be spread and how transmissible the bacterium is from person to person.

• Signs and Symptoms: Essentially unknown, available information extrapolated from animal studies. Neurotoxicity, pulmonary edema, and extensive vascular damage might be seen.
• Incubation period: Not known.
• Clostridium perfringens as a biological weapon: Aerosolized vapor.
• Mode of transmission: Presumably, inhalation. Person-to-person transmission most likely does not occur. However, there is essentially no experience with clostridium epsilon toxin infections contracted by inhalation of an aerosol, so it is not clear how it could be spread and how transmissible the bacterium is from person to person.
• Cause of death: Not known.
• Mortality rate: Not known.
Glanders

Glanders is a disease that occurs in horses, mules, and donkeys, and it is caused by the *Burkholderia mallei* bacillus. Glanders infection in humans is very, very unusual – the disease has not been seen in the United States since 1938 – but the infection in animals is common worldwide and the *Burkholderia mallei* bacillus was used during both World Wars to poison pack animals. Because of that and because of the virulence of the infection in humans, it is considered to have potential to be used as a biological weapon. The possible modes of transmission would be through breaks in the skin, ingestion of contaminated food or water, or through inhalation. The disease is very easily contracted via inhalation, and person-to-person transmission has been reported.

- Signs and symptoms: Inhalational glanders would present with fever, pneumonia, and pulmonary abscesses.
- Incubation period: 7-14 days.
- *Burkholderia mallei* bacillus as a biological weapon: Aerosolized vapor.
- Mode of transmission: Inhalation. Glanders transmission from person-to-person has been reported.
- Cause of death: Respiratory failure and/or sepsis.
- Mortality rate: 90 to 95% in the inhalational form if it is untreated.
- Diagnosis: Gram stain and tissue culture. Serologic assays are not available.
- Treatment: Amoxicillin, sulfamethoxazole/trimethoprim or tetracycline for mild cases, any of the aforementioned drugs plus imipenem for moderate cases. IV ceftazidime plus sulfamethoxazole/trimethoprim for severe cases.
- Prophylaxis of exposed, asymptomatic patients: Sulfamethoxazole/trimethoprim may be helpful, although there is essentially no clinical experience.
- Preventative treatment and vaccination: There is no vaccine.

**Learning Break:** Any surface contamination can be handled using 05% hypochlorite. Standard precautions are recommended. Respiratory precautions are not needed except for laboratory workers handling specimens.

**Learning Break:** If the patient becomes septic, the fatality rate of glanders has been reported to be as high as 95% if it is untreated.

Melioidosis

Melioidosis is a disease caused by *Burkholderia pseudomallei*: this bacterium is closely related to the *Burkholderia mallei* bacterium. The disease is common in tropical
areas of the world and it is contracted by exposure to contaminated water or soil. Person-to-person transmission can occur by contact with body secretions, and perhaps, sexual contact. *Burkholderia pseudomallei* has never been used as a biological weapon, but because of its high virulence, the ubiquity of the organism in the environment (thus the ease of attaining it), the possibility of developing antibiotic resistant strains, and the lack of a vaccine, it is considered to be a potential biological weapon.

- Signs and symptoms: Pneumonia, lung abscesses. Septicemia with multiple abscesses. People infected with HIV and people with diabetes or renal failure are more likely to develop septicemia.
- Incubation period: Not known with certainty, but probably 1-21 days.
- *Burkholderia pseudomallei* as a biological weapon: Aerosolized vapor.
- Mode of transmission: Inhalation. Person-to-person transmission is rare but has been reported.
- Cause of death: Respiratory failure and/or sepsis.
- Mortality rate: Very high (> 90%) if the patient is septic and not treated, but still high - almost 40% - even when patients are treated.
- Diagnosis: Melioidosis can be isolated from the blood, urine, sputum, or skin lesions. Detecting and measuring antibodies to the bacteria in the blood can also be done.
- Treatment: Ceftazidime, meropenem, or imipenem IV, with or without sulfamethoxazole/trimethoprim PO for 2 weeks or until a clinical response is seen. After this, sulfamethoxazole/trimethoprim or doxycycline is given PO for 60 to 150 days.
- Prophylaxis of exposed, asymptomatic patients: Sulfamethoxazole/trimethoprim may be helpful, although there is essentially no clinical experience.
- Preventative treatment and vaccination: There is no vaccine.

**Learning Break:** Any surface contamination can be handled using 0.5% hypochlorite. Standard precautions are recommended. Respiratory precautions are not needed except for laboratory workers handling specimens.

**Psittacosis**

Psittacosis is a disease caused by the *Chlamydia psittaci* bacterium. It is a common disease in birds but rare in humans. People develop psittacosis by inhaling dried secretions – usually feces – of infected birds.

- Signs and symptoms: Fever, headache, chills, muscle aches, dry cough, and pneumonia. Serious hepatic, cardiac, and neurological complications are possible.
- Incubation period: Usually 5 to 19 days, although may be longer.
- *Chlamydia psittaci* as a biological weapon: Aerosolized vapor or possibly added to a water supply.
- Mode of transmission: Inhalation, possibly ingestion. Person-to-person transmission has not been reported and is not likely.
- Cause of death: Respiratory failure.
• Mortality rate: The mortality rate for untreated cases has been estimated to be 15 to 20%. If the patient is treated, the mortality rate has been estimated to be less than 1%.
• Diagnosis: It can be difficult to make a diagnosis of psittacosis. If the patient is treated with antibiotics, the antibody response can be affected and the usefulness of serologic testing limited. *C. psittaci* can be found in respiratory secretions.
• Treatment: Doxycycline orally for 10 to 14 days.
• Prophylaxis of exposed, asymptomatic patients: Not recommended.
• Preventative treatment and vaccination: There is no vaccine for psittacosis.

**Leaning Break:** Any surface contamination can be handled using 0.5% hypochlorite. Standard precautions are recommended. Respiratory precautions are not needed except for laboratory workers handling specimens.

**Q Fever**

Q fever (meaning query fever, a fever caused by an unknown agent) is a common zoonotic disease found in goats, sheep, cattle, dogs, cats, and other animals. It is caused by the *Coxiella burnetii*, an obligate, intracellular rickettsial bacterium. (Obligate means that these organisms can only survive under certain conditions, in this case inside a cell). This organism is very resistant to heat, drying, and common disinfectants. Q fever is very, very infectious; as few as 1 to 10 organisms can cause Q fever.

• Signs and symptoms: These differ depending on the route of transmission, how virulent the strain is, and how well the host’s immune system is functioning. Most patients present with high fever, chills, gastrointestinal complaints, and myalgia. Pneumonia and liver damage are common. Serious complications such as encephalitis, myocarditis, and osteomyelitis are possible. Chronic Q fever is uncommon, but much more serious and may develop as long as 20 year after exposure.
• Incubation period: This has been estimated to be from 2 to 14 days.
• *Coxiella burnetii* as a biological weapon: Aerosolized vapor. Q fever has been developed as a biological weapon.
• Mode of transmission: Inhalation. Humans can also contract Q fever by direct contact with infected animals, by ingestion of contaminated food, via insect bites, and rarely, person-to-person transmission.
• Cause of death: Endocarditis, septicemia. Chronic Q fever is more likely to cause death; the mortality rate for patients with Q fever and endocarditis can be > 30%.
• Mortality rate: The mortality rate has been estimated to be 1 to 2%.
• Diagnosis: This can be complicated. Serologic testing and isolation of the microorganism from tissues are useful.
• Treatment: Many cases resolve spontaneously. Doxycycline or tetracycline are the antibiotics of choice.
• Post-exposure prophylaxis of exposed, asymptomatic patients: Doxycycline or tetracycline is recommended.
Preventative treatment and vaccination: There is no vaccine that is sold in the United States, but a vaccine produced in Australia may be available by an Investigational New Drug license obtained through the Department of Defense.

Learning Break: Infection with Q fever during pregnancy is serious. The bacteria colonize the placenta and uterus and can cause stillbirths, premature deliveries, and miscarriages. Unfortunately, the most effective antibiotics are contraindicated, and pregnant women should be treated with cotrimoxazole.

Learning Break: Standard precautions are recommended. Laboratory workers must use Biosafety Level 3 precautions. (Note: The CDC has outlined policies and procedures that should be used for laboratory personnel who are working with infectious agents, and Level 3 represents the highest level of caution). Quaternary ammonium solutions are recommended for disinfecting.

Ricin

Ricin is a glycoprotein that is found in the castor bean plant, *Ricinus communis*. The plant grows naturally in many parts of the world and is also cultivated for an oil, castor oil (castor oil does not contain ricin). Ricin is quite toxic: a fatal dose could be as low as 1 mg/kg.

- Signs and symptoms: The clinical signs and symptoms of ricin poisoning depend on the route of exposure. Ingested ricin causes nausea, vomiting, abdominal pain, and diarrhea. If ricin is inhaled, dyspnea, cough, and chest pain are possible. Ricin that is administered parenterally can cause fever, nausea, anorexia, abdominal pain, and hypotension. Ricin inhibits protein synthesis, can directly damage cell membrane and cell function, and multisystem organ failure is possible.
- Incubation period: This would more properly be called a latent period. If ricin is ingested, patients usually become sick 4 to 6 hours later. If ricin is inhaled, patients usually become sick 4 to 8 hours later, and ricin administered parenterally will produce signs and symptoms within 10 to 12 hours.
- Ricin as a biological weapon: Ricin could be used as an aerosol or as a food or water contaminant.
- Mode of transmission: Inhalation, ingestion or parenteral. Ricin is not contagious.
- Cause of death: Multi-system organ failure.
- Mortality rate: Ingested ricin has a mortality rare that has been reported to be between 2 to 6%. The mortality rates of inhaled and parenteral ricin are not known.
- Diagnosis: ELISA techniques have been used experimentally to detect ricin in blood and body fluids.
- Treatment: Symptomatic and supportive.
- Post-exposure prophylaxis of exposed, asymptomatic patients: Not recommended.
- Preventative treatment and vaccination: Not recommended, there is no vaccine available.
**Learning Break:** Patients who may have been exposed to aerosolized ricin should be decontaminated in an isolation area. All clothing and personal articles should be double-bagged, and the patients should be thoroughly washed with soap and water. All PPE should be washed to prevent reintroduction of ricin particles into the air.

**Typhus Fever**

Typhus fever is caused by the *Rickettsia prowazekii*. (The word typhus comes from the Greek word *typhos* which means smoky or hazy, words that can describe the mental state of someone with typhus fever) The rickettsia are bacteria that act as obligate, intracellular parasites. *Rickettsia prowazekii* is contracted by humans from infected body lice or by inhalation of their feces, or by flea bites. Once inside the cell, the toxin damages capillaries, veins, and arteries and causes a multi-organ vasculitis.

- Signs and symptoms: High fever, headache, arthralgias, and vomiting. Patients also develop a characteristic rash on their trunks and proximal parts of their arms and legs. Due to the vasculitis, gangrene is possible. Neurologic signs and symptoms are common and include coma and CNS depression.
- Incubation period: 14 days.
- *Rickettsia prowazekii* as a biological weapon: Most likely as an aerosolized vapor.
- Mode of transmission: Inhalation. Typhus is not transmitted person-to-person.
- Cause of death: Sepsis, multi-system organ failure due to vasculitis.
- Mortality rate: The mortality in untreated cases has been reported to be as high as 20%.
- Diagnosis: There are many ways to confirm the presence of typhus, e.g., detection of typhus DNA via PCR, detection of antibodies, ELISA, etc.
- Treatment: Doxycycline and chloramphenicol.
- Prophylactic treatment of exposed, asymptomatic patients: Doxycycline.
- Preventative treatment and vaccination: There is no vaccine for typhus.

**Learning Break:** Standard precautions are sufficient.

**Staphylococcus Aureus Enterotoxin B**

The *Staphylococcus aureus* bacteria produce seven enterotoxins (Note: An enterotoxin is a toxin that is produced by bacteria and affects the intestinal mucosa). The enterotoxin B is the most common cause of food poisoning, and it is transmitted to humans when they eat contaminated food. It has properties that make it attractive as a biological weapon: it is easily attained, it can be easily mass produced, it is resistant to temperature fluctuations and to heat, it is stable when made into an aerosol, and it could easily be introduced into food supplies or water sources. Also, as it is naturally occurring and very common, a terrorist attack that caused an outbreak of illness through the use of *Staphylococcus aureus* may not be noticed. It is also quite dangerous: the LD$_{50}$ has been estimated to be 0.02 mcg/kg.
• Signs and symptoms: Enterotoxin B stimulates the release of cytokines (mediators of the immune response) and nausea, vomiting, diarrhea, and abdominal pain begin. If the toxin is inhaled, people develop high fever, headache, dyspnea, and chills.
• Incubation period: For ingested toxin, 3 to 12 hours. For inhaled toxin, 1 to 6 hours.
• *Staphylococcus aureus* enterotoxin B as a biological weapon: Aerosol or a food/water contaminant.
• Mode of transmission: Inhalation or ingestion. There is no person-to-person transmission.
• Cause of death: Septicemia or hypovolemic shock.
• Mortality rate: This varies greatly and depends on the patient’s age, pre-existing medical conditions, the integrity of the victim’s immune system, the virulence of the strain, and the quality and timeliness of medical care.
• Diagnosis: Enterotoxin B can be isolated in the stool or the blood using ELISA.
• Treatment: Symptomatic and supportive care.
• Prophylactic treatment of exposed, asymptomatic patients: No prophylactic measures are available.
• Preventative treatment and vaccination: There is no vaccine for this toxin.

**Learning Break:** Standard precautions are sufficient.

**Vibrio cholerae**

Cholera is a disease caused by the gram-negative, aerobic *Vibrio cholerae* bacillus. The bacillus produces an enterotoxin that causes secretions of fluids and electrolytes into the lumen of the small intestine. It is contracted by the fecal-oral route.

• Signs and symptoms: Painless, watery diarrhea that is very profuse. Abdominal cramps and nausea are common. The patients are not febrile.
• Incubation period: For ingested *Vibrio cholerae*, the incubation period is thought to be 24 to 48 hours.
• *Vibrio cholerae* as a biological weapon: Food and water contaminant.
• Mode of transmission: Ingestion. Person-to-person transmission is rare.
• Cause of death: Hypovolemic shock.
• Mortality rate: If untreated, the mortality rate can be as high as 50%.
• Diagnosis: The bacillus can be isolated in stool.
• Treatment: Symptomatic and supportive care. Antibiotics (e.g., azithromycin, tetracycline, doxycycline, ciprofloxacin, etc.) can be used.
• Prophylactic treatment of exposed, asymptomatic patients: Not recommended.
• Preventative treatment and vaccination: The standard, injectable cholera vaccine is only about 50% effective at preventing the disease. There is an oral vaccine that can be used to prevent illness caused by *Vibrio cholerae*, but it is not available in the United States.
Learning Break: Standard precautions are sufficient.

Viral Encephalitis

Viral encephalitis is an illness caused by the equine encephalomylelitis viruses. These viruses are part of the genus *Alphavirus*, and the most common species are the Venezuelan, Eastern, and Western. Viral encephalitis is a naturally occurring disease that causes inflammation of the brain and spinal cord. These viruses can easily be grown and if they were aerosolized they would be highly infectious.

- **Signs and symptoms:** High fever, headache, nausea, vomiting, anorexia, weakness, altered mental status, somnolence, seizures, focal neurological deficits, and coma. There is often a prodromal phase of 5-10 days when the patient has fever, headache, and gastrointestinal complaints. Many patients affected with Eastern equine encephalitis suffer permanent neurological impairment.
- **Incubation period:** Usually 5-10 days.
- **Equine encephalomylelitis viruses as biological weapons:** Aerosolized vapor.
- **Mode of transmission:** Inhalation. There is no person-to-person transmission.
- **Cause of death:**
- **Mortality rate:** For Eastern equine encephalitis, the mortality rate can be as high as 70%. For Venezuelan equine encephalitis, the mortality rate can be as high as 20%, and for Western equine encephalitis the mortality rate has been estimated to be
- **Diagnosis:** Cultures of the cerebrospinal fluid (CSF) or ELISA testing.
- **Treatment:** Symptomatic and supportive care.
- **Prophylactic treatment of exposed, asymptomatic patients:** Nothing available.
- **Preventative treatment and vaccination:** There are no commercially available vaccines.

Learning Break: Standard precautions are sufficient.

**CATEGORY C AGENTS**

The Category C agents are considered to be potential threats; it is not known if these microorganisms have actually been developed into biological weapons. Nonetheless, they are considered a threat because they are easily available, they can be easily produced and disseminated, and they could cause significant morbidity and mortality.

**Hantavirus**

The Hantavirus is part of the Bunyaviridae viruses. These viruses are found virtually everywhere, and they would be excellent biological weapons because they are easy to obtain, easy to replicate, and the natural immunity of most people would be low. The hantavirus produce two clinical syndromes, the hantaviral fever with renal syndrome (HFRS) and the hantaviral pulmonary syndrome (HPS).
HFRS causes shock, hemorrhage and renal failure. It is less common and not as deadly as HPS. The pathophysiologic mechanism of HFRS is not clearly understood. Some experts believe it is an allergic response to antigens; it is also thought that activation of an exaggerated immune response may be responsible.

As a naturally occurring disease, HPS happens when people inhale the dried feces and urine of infected rodents. The virus increases the permeability of pulmonary capillaries and causes pulmonary edema. It may also act as a myocardial depressant. HPS is a dangerous disease.

- **Signs and symptoms:** The illness starts with a prodromal phase during which the patient develops a high fever and myalgias, particularly in the large muscles of the thighs and lower back. Following that, cough and dyspnea are seen and respiratory failure can develop. HFRS is distinguished by the triad of renal failure, fever, and hemorrhage.
- **Incubation period:** Approximately 2 weeks for HPS, approximately 4 to 42 days for HFRS.
- **Hantavirus as a biological weapon:** Aerosolized vapor.
- **Mode of transmission:** Inhalation. The virus is also spread when people eat food contaminated with the feces or secretions of infected animals. There is no person-to-person transmission.
- **Cause of death:** Respiratory failure, shock, renal failure.
- **Mortality rate:** This has been reported to be as high as 35% for HPS, approximately 5 to 15% for HFRS.
- **Diagnosis:** Hantavirus can be detected using ELISA, by special tissue staining, and by RT-CP testing of tissues.
- **Treatment:** Symptomatic and supportive.
- **Prophylactic treatment of exposed, asymptomatic patients:** Nothing available.
- **Preventative treatment and vaccination:** There is no vaccine that can be used to prevent illness caused by hantavirus.

**Learning Break:** Standard precautions are sufficient for protection against hantavirus.

**Nipah Virus**

The Nipah virus is a member of the Paramyxoviridae virus family. Experience with infection in humans is limited.

- **Signs and symptoms:** Fever, headache, myalgias, dizziness, and gastrointestinal complaints. Encephalitis causing coma is common, and other neurological findings, e.g., decreased/absent reflexes, myoclonus, tonic-clonic seizures may be seen. The prognosis is poor for people with significant neurological impairment.
- **Incubation period:** Approximately two weeks.
- **Nipah virus as a biological weapon:** Aerosolized vapor.
- **Mode of transmission:** Inhalation. Nipah virus can be transmitted from person to person. It can also be spread by ingestion of contaminated food.
• Cause of death: Encephalitis.
• Mortality rate: Estimated to be 40 to 75%.
• Diagnosis: The Nipah virus can be cultured in CSF and antibodies can be detected in blood or CSF.
• Treatment: Symptomatic and supportive.
• Prophylactic treatment of exposed, asymptomatic patients: Nothing available.
• Preventative treatment and vaccination: There is no vaccine that can be used to prevent an illness caused by with Nipah virus.

Learning Break: Standard precautions are sufficient for protection against Nipah virus.

CHEMICAL AGENTS USED FOR TERRORISM

Chemical agents have been used for warfare and terrorism for thousands of years. They were first used extensively - and effectively - during World War I when the German army released chlorine gas against British and Canadian troops in 1915, and gas attacks became a relatively common part of warfare during that conflict. Since that time chemical agents have been used as weaponry far less frequently. However, chemical warfare was used by Japan in the 1930s during its invasion of China, the Soviet Union used chemical weapons during its occupation of Afghanistan in the 1970s and1980s, the Iraqi military used mustard gas and nerve agents during the Iraq-Iran war and against the Kurdish population of Iraq in the 1980s and 1990s (mustard gas, cyanide gas, and other chemicals), and there are unconfirmed reports that in 2011 the government of Yemen used poison gas to suppress anti-government protests. Those are just a few well-known examples of the recent use of chemical warfare, and there are (possibly) at least a dozen countries that have chemical weapons. Although chemical weapons have not, at this time, been used for large-scale terror attacks it is a definite possibility.

Chemical agents have advantages and disadvantages as terror weapons.

• They are relatively quick and easy to produce and they can be made from easily obtained materials.
• There is a large number of chemical that can be used for terrorism.
• Chemical weapons require expensive and difficult to hide delivery systems.
• Chemical weapons are difficult to use surreptitiously.
• Large amounts/volumes of chemical weapons are required to maximize the number of casualties.
• Delivering chemical weapons - in amounts that would affect a large number of people – is technically difficult and accurately reaching the intended target is technically difficult: using a chemical weapon is not as simple as pointing a firearm.
• A chemical weapon attack will usually produce signs and symptoms that are obvious and can’t be ignored or attributed to a naturally occurring illness. Chemical weapons themselves are usually obvious (e.g., a visible gas/vapor, a distinctive odor), and the effects of a chemical weapons attack are usually immediate – something that can be very advantageous for a terrorist.
• A chemical weapon attack will usually produce signs and symptoms that are obvious to the victim and to health care personnel, but the clinical presentation is often non-specific.
• Some chemical weapons can be absorbed through the skin and many can be absorbed through inhalation. Biological weapons (with the exception of the mycotoxins) are not absorbed through the skin and although biological weapons can be absorbed by inhalation, they are not naturally volatile.

There are dozens of chemicals that can be used for terrorism. This module will divide the chemical weapons into four categories – blister agents, blood agents, choking agents, nerve agents, and riot control agents – and only the ones that are most likely to be used (or have been used) will be covered. In each of those categories there are many more chemicals that could be used for terror, but the signs and symptoms produced by any particular one would not be significantly different from any other and the treatments would be the same.

BLISTER AGENTS

The blister agents - also called vesicants – are nitrogen mustard, sulfur mustard, and lewisite. Although the blister agents rarely cause death and they are valued more for their ability to incapacitate than to cause morbidity or death, they can cause severe, painful, and long-lasting injuries. Sulfur mustard has been extensively used, and it is still produced. Lewisite and nitrogen mustard were developed as warfare agents but they have not have not been used. Because of this and because the clinical effects of these three blister agents are essentially the same, lewisite and nitrogen mustard will not be discussed.

Sulfur Mustard

Sulfur mustard – more commonly known as mustard gas – was first used as an agent of warfare in World War I. It is still stockpiled by several countries, and it was definitely used by Iraq in the 1980s during its war with Iran and during Iraq’s attacks on the Kurdish population of Iraq. Mustard gas is an organic sulfide and in the liquid form it is an oily, yellow, brown, or black liquid. People would be exposed to sulfur mustard as a liquid and as a vapor.

- Routes of exposure: Mustard can be absorbed dermally, by ingestion, and by inhalation. Ocular exposure produces painful signs and symptoms.
- Mechanism of injury: For the skin and the respiratory tract, it is thought that mustard causes a liquefaction necrosis and damages the dermal proteins that act as an anchor for the epidermis.
- Clinical effects: a) Ocular irritation and burns, b) skin irritation and burns, and c) respiratory distress. The degree of injury depends on the concentration of the mustard, the time of exposure, and whether the victim was exposed to the liquid or the vapor: the liquid is more injurious. Although the fatality rate associated with exposure to mustard is low, the skin burns, ocular damage, and respiratory
Distress can be severe. Bone marrow suppression can happen to a severely poisoned patient. The fatality rate is low (approximately 2%-3% reported during World War I) and death is caused by pulmonary insufficiency.

Learning Break: The onset of effects from a mustard exposure is typically delayed. If the victim is exposed to a low concentration for a short period of time the latent period between the exposure and the onset of the dermal effects can be up to 24 hours. Ocular signs and symptoms happen much earlier after an exposure (a few minutes to an hour) and the latent period for the development of respiratory distress is usually 4-6 hours.

- Decontamination: All clothing should be removed and should be double bagged. Mustard can penetrate clothing so the victims must be disrobed and completely washed with soap and water. Flush the eyes with normal saline.
- Personal protective equipment: Patients who have been decontaminated at the scene do not require further decontamination. If the patients self-refer, they should be decontaminated outside the health care facility. Personnel decontaminating victims should wear goggles, chemical resistant inner and outer gloves, a pressure-demand self-contained breathing apparatus, and impermeable protective clothing including shoe covers.
- Treatment: Symptomatic and supportive.

**BLOOD AGENTS**

Blood agents are chemical weapons that interfere with cellular respiration. Cyanide is the blood agent that has been used most often for chemical warfare; it was used by the French in World War I, it was used in World War II by the Nazis in the death camps, and Iraq used cyanide against its Kurdish population in the 1980s. It is a very effective chemical warfare agent because it is easy to produce, difficult to detect, and highly toxic.

- Routes of exposure: Cyanide can be absorbed dermally, by ingestion, and by inhalation. The most likely route of exposure if cyanide was used for terrorism would be inhalation of cyanide vapor.
- Mechanism of injury: Cyanide disrupts cellular respiration by inhibiting cytochrome oxidase, an enzyme that is needed for electron transport in the mitochondria. The result is a profound state of hypoxia state that affects virtually every part of the body. The central nervous system, especially the respiratory center of the brain, is especially vulnerable.
- Clinical effects: People who are exposed to a high concentration of cyanide suffer cardiac and respiratory arrest within seconds to minutes. Because cyanide vapor is absorbed so quickly and works so fast, an exposure to cyanide is very often an “either/or” situation: patients collapse and cannot be resuscitated or they have mild signs and symptoms that resolve very quickly. Patients who do not succumb quickly will have signs and symptoms of hypoxia: headache, dyspnea, tachycardia, tachypnea, etc.
- Decontamination: Decontamination in most cases of cyanide exposure would involve simply removing the patient from the area. Cyanide vapor dissipates very
quickly and unless patients have cyanide liquid on their skin, secondary contamination is very unlikely. However, victims should be disrobed and their skin washed with soap and water before they are admitted to treatment areas.

- **Personal protective equipment**: Once patients have been decontaminated there is no need for personal protective equipment. Personnel decontaminating patient who have been exposed to cyanide vapor should wear goggles, chemical resistant inner and outer gloves, a pressure-demand self-contained breathing apparatus, and impermeable protective clothing including shoe covers.

- **Treatment**: The cyanide antidote – sodium thiosulfate – should be given to patients with a confirmed cyanide exposure who have significant signs and symptoms. Sodium thiosulfate converts cyanide to a far less toxic compound, thiocyanate. Give 12.5 grams (50 mL of a 25% solution) IV at a rate of 2.5-5 mL/minute. If needed, half of this dose can be given 30-60 minutes after the initial dose. First responders may also use sodium nitrite in the form of amyl nitrite inhalation capsules or sodium nitrite IV. The nitrites produce methemoglobinemia, and methemoglobin binds cyanide and prevents it from binding to hemoglobin. However, methemoglobin cannot carry oxygen, so administration of nitrites in cases of cyanide poisoning requires a careful evaluation of the risk-benefit ratio. Other treatments for cyanide poisoning are symptomatic and supportive.

**CHOKING AGENTS**

The choking agents are used to incapacitate. However, some of these chemical weapons can, if the exposure is significant, cause serious harm. Phosgene and chlorine have been used for chemical warfare, they can have systemic effects, and they could used for terrorism. The riot control agents (more commonly known as tear gas) are also choking agents. They produce sign and symptoms similar to those caused by exposure to phosgene and chlorine, but serious harm is not likely. They are widely available and used by quite often by law enforcement officers.

**Phosgene**

Phosgene was used extensively during World War I. It is highly toxic gas, and it is particularly dangerous because even small amounts can be harmful. It is also very dangerous because the odor detection threshold is higher than the air level that is dangerous: by the time it can be detected by smelling, the air concentration is dangerously high.

- ** Routes of exposure**: Inhalation and ocular. Dermal irritation can occur if the skin is moist.
- **Mechanism of injury**: When phosgene comes into contact with water in the respiratory tract and on the skin it forms hydrochloric acid. Phosgene can also deplete surfactant in the lungs. Because phosgene has low water solubility the distal branches of the bronchial tree can be affected. The choking agents also act as simple asphyxiants.
Clinical effects: Phosgene can cause eye and skin irritation and systemic effects are possible, but respiratory distress is the primary and most obvious effect. The onset of the respiratory signs and symptoms is delayed. Severe pulmonary edema is possible with large fluid shifts and significant hypoxia, and permanent damage to the lungs is possible.

Decontamination: All clothing should be removed and double bagged. The victims should be disrobed and washed with soap and water. Flush the eyes with saline solution.

Personal protective equipment: Patients who have been decontaminated at the scene do not require further decontamination. If the patients self-refer, they should be decontaminated outside the health care facility. Personnel decontaminating victims should wear goggles, chemical resistant inner and outer gloves, a pressure-demand self-contained breathing apparatus, and impermeable protective clothing including shoe covers.

Treatment: Symptomatic and supportive.

Chlorine

Chlorine is another choking agent that was used extensively in World War I.

Routes of exposure: Inhalation and ocular. Dermal irritation can occur if the skin is moist.

Mechanism of injury: When chlorine comes into contact with water on the respiratory tract and the skin it forms hydrochloric acid. The water solubility of chlorine is less than that of phosgene, so upper airway signs and symptoms are more apt to occur. The choking agents also act as simple asphyxiants.

Clinical effects: Chlorine can cause eye and skin irritation and systemic effects are possible, but respiratory distress is the primary and most obvious effect. The onset of the respiratory signs and symptoms is almost immediate. Severe pulmonary edema is possible with large fluid shifts and significant hypoxia. Chlorine is much less likely to cause permanent damage to the lungs than phosgene.

Decontamination: All clothing should be removed and double bagged. The victims should be disrobed and washed with soap and water. Flush the eyes with saline solution.

Personal protective equipment: Patients who have been decontaminated at the scene do not require further decontamination. If the patients self-refer, they should be decontaminated outside the health care facility. Personnel decontaminating victims should wear goggles, chemical resistant inner and outer gloves, a pressure-demand self-contained breathing apparatus, and impermeable protective clothing including shoe covers.

Treatment: Symptomatic and supportive.

NERVE AGENTS
The nerve agents are among the most deadly of the chemical warfare agents, and they are highly toxic. There are 5 nerve agent chemical weapon compounds that have been developed and although there are some differences between them, they all have the same mechanism of action and they are all very dangerous. The nerve agents are: GA (also known as tabun), GB and GF (also known as sarin), GD (also known as soman), and VX.

- Routes of exposure: The nerve agents can be delivered as liquids or vapors, and they can be absorbed dermally, ocularly, and by ingestion and inhalation.
- Mechanism of injury: The nerve agents bind to and irreversibly inactivate acetylcholinesterase, the enzyme responsible for the breakdown of acetylcholine. This results in persistent stimulation of the muscarinic and nicotinic receptors.
- Clinical effects: The nerve agents cause a cholinergic crisis. Patients present with a syndrome that can best be characterized by the acronym **DUMBELS**: Diarrhea and Diaphoresis, Urinary incontinence, Miosis, Bronchorrhea, Emesis, Lacerimation, and Salivation. Muscle weakness, fasciculations, bradycardia, and tachycardia also occur. In severe exposures, patients succumb very quickly from apnea and seizures.
- Decontamination: The patients should be completely disrobed and the skin washed with bleach and water solution: mild detergents can be used if bleach is not immediately available. The eyes should be flushed with tepid water.
- Personal protective equipment: Personnel who are decontaminating victims exposed to a nerve agent should wear goggles, chemical resistant inner and outer gloves, a pressure-demand self-contained breathing apparatus, and impermeable protective clothing including shoe covers. If the patients have been thoroughly decontaminated there is little risk to health care personnel. If patients self-refer they must be decontaminated in a special area because secondary contamination from liquid on the skin and vapor trapped underneath clothing is a real possibility.
- Treatment: Airway protection and oxygenation are paramount. Nerve agents kill people by causing respiratory muscle paralysis and bronchorrhea to a degree that seriously interferes with oxygen diffusion. The basic treatment for exposure to a nerve agent is symptomatic/supportive care, e.g., benzodiazepines for seizures. However, seriously poisoned patients will need antidotal therapy.
- Antidotal treatment: Atropine blocks the action of acetylcholine and will decrease the respiratory secretions. The dose is 0.5-2.0 mg IV. Double the dose every 5 minutes until atropinization has occurred (i.e., decreased secretions, decreased wheezing, increased oxygen saturation). **Patients who have been poisoned with a nerve agent and are severely symptomatic will need very large amounts of atropine, perhaps as much as 100 mg in several hours.** Pralidoxime (a.ka. 2-PAM) is the other antidotal drug used to treat nerve agent poisoning. Pralidoxime works by breaking the nerve agent-acetylcholinesterase bond and protecting unaffected acetylcholinesterase. The dose is 1-2 grams, in 100 mL of normal saline solution given over 15-30 minutes. Pralidoxime is most effective if it is given soon after exposure because if the nerve agent binds to acetylcholinesterase past a certain time period, the enzyme cannot be regenerated.

**Riot Control Agents**
Riot control agents that are commonly available and may be used for terrorism include CN, CR, and CS. CN is commonly known as mace. The resin of pepper plants, capsicum (commonly known as pepper spray) is also used as a riot agent. CN, CS, and CR are delivered as aerosols: an aerosol is defined as liquid or solid particles suspended in a gas. There are no significant differences in the signs and symptoms caused by CN, CR, and CS, but CR is considered to be less toxic than CN and CS. The riot control agents are favored by law enforcement because they are temporarily disabling and they rarely cause serious injuries. It has been estimated that the lethal amount of riot control agents such as CN, CS, and CR is approximately 2600 times the amount needed to produce disabling signs and symptoms.

- Routes of exposure: Inhalation, ocular, and dermal.
- Mechanism of injury: The riot control agents are very strong sensory irritants. The mechanism of action/injury of these agents is not clearly or completely understood.
- Clinical effects: Ocular irritation and respiratory irritation are the most common effects of exposure to a riot control agent. Nausea and vomiting are also possible. Serious harm/damage such as corneal abrasion, laryngospasm, pulmonary edema, or skin burns is possible but uncommon.
- Decontamination: Remove contaminated or possibly contaminated clothing. Wash the skin with soap and tepid water. Flush the eyes with large amounts of water.
- Personal protective equipment: Secondary contamination is possible; dermal effects from secondary contamination would be more likely than ocular or respiratory effects. If the patient has been decontaminated in the field, no personal protective equipment is needed. If the patient has not been decontaminated before arriving at the health care facility, they should be decontaminated outside general treatment areas and the staff should wear protective outer garments, chemical resistant gloves, and a respirator.
- Treatment: Symptomatic and supportive.

**RADIOLOGICAL TERRORISM**

Radiological weapons have not yet been used for terrorism attacks. Obtaining the materials and delivering the weapon poses formidable practical difficulties. However, although a nuclear weapon attack is extremely unlikely, there are other ways of using radiation as a weapon and these methods - a radiation emission device or a radiation dispersal device (a.k.a. a dirty bomb) - are within the capabilities of a determined terrorist group.

**Basic Information About Radiation**

Radiation is energy, and the type of radiation that would be used for terrorism is ionizing radiation. Ionizing radiation occurs when the nucleus of an unstable atom loses an electron or a photon. A substance that is emitting ionizing radiation is said to be
radioactive. The radiation can be in the form of alpha particles, beta particles, gamma particles, or neutrons. These particles and the neutrons can cause radiation poisoning if someone is exposed to high amounts of beta or gamma radiation for a sufficient period of time. Radiation poisoning can be acute or chronic and it is characterized by a) gastrointestinal signs and symptoms, b) hematopoietic signs and symptoms, c) neurological signs and symptoms, and d) development of cancer.

If radiation were to be used for terrorism, it would be used in the form of a) a radiation emitting device, or b) a radiation dispersal device, also known as a “dirty bomb,” and the latter would be much more likely to happen (Note: A nuclear explosion is a very remote possibility). In either instance, a radioactive material such as cobalt-60, cesium-137, strontium-90, or americium-241 would be used because these materials have a long half-life and emit large amounts of radiation. A radiation emitting device would be a surreptitiously placed source of radiation that would, over time, emit harmful amounts of radiation and (possibly) put people at risk for cancers. A radiation dispersal device would be a conventional explosive weapon – a bomb – that has had radioactive material added. Explosion of a radioactive dispersal device would be far more dramatic and would require the most acute care, and it would probably be the weapon of choice for radiological terrorism.

People exposed to a radiation dispersal device would suffer trauma from the explosion, they would be contaminated with radioactive material, and they would be at risk for developing cancer from the radiation exposure. Almost none of the victims and very few of the health care professionals caring for them would be knowledgeable about the risks and the appropriate care, and the level of fear and anxiety for patients and caregivers would be certainly be quite high. However, although the explosion of a radiation dispersal device/dirty bomb is a frightening prospect, caring for people exposed to a dirty bomb would not be complicated or difficult.

- **Routes of exposure:** Most of the victims would be exposed dermally: radioactive material would adhere to skin but it would not be absorbed through intact skin. However, the radioactive material released from a radiation dispersal device could also be inhaled, absorbed dermally through open wounds, and ingested.
- **Mechanism of injury:** Trauma from the explosion. Radiation poisoning damages critically important cell structures. Radiation poisoning can be acute or chronic.
- **Clinical effects:** Trauma from the explosion. Acute radiation poisoning (characterized by rapid onset and progression of signs and symptoms) happens if people are exposed to very large amounts of radiation in a short period of time. Chronic radiation poisoning happens when people are exposed to low amounts of radiation over a long period of time. There would be no risk of acute radiation poisoning from a dirty bomb explosion and there would be very little risk of chronic radiation poisoning.
- **Decontamination:** Patients should be decontaminated in a separate, confined area. In the case of exposure to a dirty bomb, removing the victim’s clothing will remove the majority of the radioactive material. This is best done by cutting the clothing and rolling it away from the patient, trapping radioactive material inside the clothing. The clothing should be double bagged and clearly marked as contaminated. Once the patient has been undressed, wash the skin and hair several
times with soap and water. If needed, the eyes can be flushed with saline. If radioactive material has been inhaled, swab the nasal passages with saline. Radioactive material cannot be neutralized: it can only be removed and safely contained, so it is important to control any possible spread.

**Learning Break:** Patients who are contaminated with radioactive material should be isolated in a special area, but medical care should not be delayed in favor of decontamination. Treat the patient first.

- **Personal protective equipment:** People who are exposed to radiation but are not contaminated with radioactive material are not a risk to other patients or to health care personnel. It is impossible for a patient to be so contaminated that she/she is a radiation hazard to health care personnel. The variables involved in radiation poisoning are time, proximity to the source, and amount of exposure. Nurses and other health care personnel caring for people who have been exposed to radioactive material from a dirty bomb would not be close enough to a large enough amount of radioactive material for a long period of time to be at risk. No healthcare provider has ever had a significant radiation exposure from treating a contaminated patient. Ordinary personal protective equipment – gloves, gowns, and shoe covers – are quick and easy to put on, they would protect you from any contamination, and because they are discarded after use they help prevent the spread of radioactive material. If there is a concern for inhaling a significant amount of radioactive material, respirators should be worn.

- **Treatment:** There are specific treatments that can be used for exposures to specific radioactive materials. However, identifying what the victims have been exposed to (e.g., exposure to americium-241, cesium-137) can take time and when patients first present to a health care facility this information will not immediately be known. The first priorities would be to a) treat injuries caused by the explosion of the radiation dispersal device, b) decontaminate wounds, and c) assess the level of radiation exposure. Injuries would be treated with standard care. Wounds are decontaminated by first cleaning the area around the wound in order to prevent radioactive material from entering the wound, and this can be done by using saline and gauze pads. The wounds can be cleaned out using sterile saline; the runoff should be collected and disposed of properly. If the wounds need to be closed, standard surgical scrubbing can be used before this is done. Partial thickness burns should be irrigated and then cleaned with a mild solution. Assessing the level of radiation exposure would be done using a radiation survey meter, and health care facilities should have a radiation safety officer who is trained to use the device. The reading should be carefully documented on the patients’ charts, and the patient should be assessed again after decontamination.

**SURVEILLANCE FOR BIOLOGICAL, CHEMICAL, OR RADIOLOGICAL TERRORISM**

A terrorist attack using chemical or radiological weapons would (with the exception of the use of a radiation emitting device) be obvious and easily detected. However, the
effects of biological weapons are identical to, or closely mimic, the syndromes caused by these organisms or toxins when people are exposed to them in the natural environment or the syndromes caused by naturally occurring diseases. Biologic warfare agents often produce illnesses that are characterized by an incubation period, making it difficult to link an attack or a suspicious incident that occurred days or weeks prior to a patient’s complaints.

Because of these features of biological weapons, *surveillance* is critically important in order to protect against an attack from biological weapons and to detect such an attack. The Centers for Disease Control and Prevention (CDC) defines surveillance systems as methods and systems for collecting and analyzing morbidity, mortality, and other relevant data and distributing this information in a timely manner to appropriate decision makers. The data would be collected from emergency rooms, physicians, laboratories, pharmacies, hospitals, public health departments and a wide variety of other sources (e.g., data about school absenteeism, work absenteeism, discharge diagnosis data, information and statistics from medical examiners) and then collected and analyzed. The systems in place now automatically extract this data from the sources and if the data indicate a problem, a focused investigation can be launched.

**Learning Break:** One way that information public health threats such as a bioterrorism attack can be disseminated is the Health Alert Network. The Health Alert Network (HAN) is a program sponsored by the Centers for Disease Control and Prevention. The HAN messaging system connects with state and local health officials and provides them with information about potential or actual threats to public health. The information can be in the form of a Health Alert – a situation that requires immediate action – or in the form of Health Advisories, Health Updates, or general information.

At this point in time, the surveillance systems are primarily local and state based. These agencies can be more flexible and responsive and communication more timely than it could be with surveillance systems operating on a national level. There is no single surveillance system in use today, but the ones that are commonly used look for patterns that would be associated with *syndromes* that would be caused by an agent such as anthrax, plague etc. Syndromic surveillance has the capacity to quickly detect even small incidents. Collecting the data is relatively simple. Interpreting the data and deciding if and when an event may indicate a possible bioterrorism incident and what to do about the event is not so simple. The consequences of incorrectly responding to data as if a real bioterrorism attack were occurring – or not responding if there was an attack – would very serious.

**PREPARATION, RECOGNITION AND RESPONSE FOR TERRORISM**

Handling a terrorist attack involving biological, chemical, or radiological weapons involves preparation, recognition, and response. Each of these would offer its own challenges, but the preparation for, recognition of, and response to a terrorist attack involving the use of biological weapons can be used as a model. It is sensible and prudent for nurses and emergency personnel to be aware of the possibility of an attack with biological weapons, to know what types of agents might be used, to be familiar with
the signs and symptoms that each would produce, and have knowledge of the appropriate treatments.

But how easy – or practical – is that to do? There are, clearly, a lot of different microorganisms and toxins that can be used for bioterrorism. The clinical picture that each produces often have some overlap and can easily mimic other far more common diseases, it would almost impossible to memorize the treatments that would be used for each one, and the diagnostic testing that is needed to confirm that one of these agents has been used as a biological weapon is often not available in most health care facilities.

However, these concerns, while certainly real and important, overshadow the fact that there are other crucial aspects of managing a bioterrorism attack: being prepared, and following the principles of recognition, avoidance, isolation, and notification, aka RAIN.

Preparation for A Biological Weapons Attack

Preparation is essential for effectively managing a biological weapons attack. Much of the work involved in preparing for bioterrorism incidents is done at the administrative level, i.e., arranging education classes and training personnel, obtaining and maintaining equipment, coordinating with regional emergency medical services, etc. However, nurses are often called on to work with other health care facility personnel and administrative staff to develop policies and procedures.

The first task that needs to be accomplished is the formulation of a plan. Hospitals are required to have an emergency preparedness plan in place and to have drills to test the plan twice a year and to participate in a community-wide drill at least one a year. These plans are very complex, as they involve issues of triage, communication, security, decontamination, training, and coordination with other emergency agencies. A full review of all the aspects of an emergency preparedness plan would be very lengthy, and this module will focus on issues that commonly arise in implementing an emergency preparedness plan. The following are vitals aspects of being properly prepared:

• Anticipation: Unfortunately, hospitals have at times adopted the attitude that because of their size and location, they would be unlikely to receive victims of an attack from a biological weapon. They have also reasoned that if such an attack occurred, their size and location would limit the amount of patients they would receive and any patients they were not equipped to treat could simply be transferred to another facility. However, the sarin gas attack in the Tokyo subway clearly showed that these are dangerous assumptions. Hospitals cannot control who will come seeking help, and transferring large amounts of patients to other hospitals in these situations is not an option. Be prepared for the worse and never adopt the attitude that it can’t happen here.

• Communications: Internal and external communications during a disaster often break down. The systems become overloaded and backup methods may not be familiar to the staff that needs to use them. Staff that may be involved in a biological weapons attack must know how to use these systems, and they must also be familiar with who should be called, e.g., local EMS system, police, CDC, etc.
• Security: Security is often overlooked as a concern during a disaster, but hospitals may be a secondary target for terrorists, and security personnel are essential for directing the flow of people in and out of the facility, protecting the staff, and prevent inadvertent contamination of an area by the improper movement of inpatients or arriving patients. There should be a clear plan for involving security personnel.
• Decontamination of patients: This is obviously an issue of great concern, as staff is concerned not only with patient safety but also with the potential for contaminating themselves, other patients, and the environment. Fortunately, decontamination is not as critical an issue in a biological weapons attack as it would be in an attack with a chemical agent. However, in the early stages of the influx of mass casualties from a terrorist attack, it may not be clear that biological, not chemical weapons have been used. Also, decontamination is important for some biological agents, e.g., anthrax in the powder form or tricothecene mycotoxin (T2). Fortunately, decontamination of patients is not complicated. Doing it right simply involves having the right equipment, having a plan, and practicing. Ordinary soap and water should be used; potentially harmful chemical such as bleach should not.
• The use of personal protective equipment: It is always stressful to be in an emergency, and this stress can be increased if the staff is required to use personal protective equipment (PPE) that they are unfamiliar with. Most times, simple gowns and gloves and mask are required, but specialized respirators may be needed as well.

Learning Break: Hospital staff must remember that although a good disaster plan that is frequently practiced is essential, if there is a large-scale attack with a biological weapon, the hospital resources could be quickly exhausted.

Recognition

Recognizing that you are caring for someone who has been the victim of an attack with a biological weapon is absolutely critical. One astute community physician is credited with recognizing a sentinel case of inhalational anthrax in 2001 and this is thought to have saved hundreds of lives. But how can recognition best be done? As mentioned previously, the clinical picture that these microorganisms and toxins produce can easily be mistaken as being caused by a less serious and far more common disease and confirmation of their presence cannot practically be done on an emergent basis. It is important to be know about anthrax, smallpox, plague, etc. and the signs and symptoms caused by an infection with them, but trying to guess what someone has been exposed to – and in the early hours after an attack that is all that could be done – would not be sensible or effective.

The answer is for nurses and other health care professionals to be aware.

• Clinical course: The microorganism and toxins that would likely be used as biological weapons are chosen because they are dangerous and they would typically produce a clinical course of rapid, severe deterioration.
• Intensity of signs and symptoms: Although in many cases, there are common or relatively common diseases that may cause signs and symptoms similar to those caused by a biological weapon, the patients exposed to the latter would be expected to be far sicker.

• Clusters of cases: Watching for clusters of cases that might fit the profile of people who have been exposed to a biological weapon is a vital step. Be especially watchful for patients who are otherwise healthy who present with an acute onset of a high fever, a rash, or an acute neurological condition. If the patients have not recently returned from an overseas country, this should heighten your level of suspicion.

• Level of acuity: A person who has been exposed to one of the organisms previously discussed will have signs and symptoms that may mimic common illnesses, but they will also be much, much sicker; these diseases are chosen because they are highly virulent.

• Geographical clues: Are all the patients coming from a narrowly circumscribed area? This could be a clue that they are victims of bioterrorism.

Avoidance

Avoidance means preventing contamination of the staff, other patients, and the environment. Fortunately, when the microorganisms discussed here are used as biological weapons, they are not generally spread from person-to-person (although there are exceptions such as smallpox and plague) and the possibility that these agents could re-aerosolize is remote. However, when faced with the possibility of dealing with a biological weapons attack, there are some guidelines that should be used to prevent further harm.

• Use standard precautions: These are well known to all nurses and most hospital personnel, and include the use of gowns, gloves, mask and eye protection, good handwashing, and strict avoidance of contact with body fluids.

• Decontamination of equipment and patient clothing: Standard precautions apply until otherwise instructed.

Isolation

Unfortunately, in the event of an attack with a biological weapon, rapid detection and confirmation of the particular weapon is not possible, so it is not practical to immediately know which patients should be placed in isolation and the problem would be compounded if there are large numbers of patients seeking help. Fortunately, the majority of the agents that were discussed are not transmitted person-to-person, but there are exceptions, e.g., smallpox. The safe and sensible answer to this problem is to 1). Use standard precautions at all times in these situations, 2) limit or prohibit – if possible – nurses who are caring for these patients from having contact with other patients, 3) prohibit these patients from having contact with other patients, and 4) notify infection control immediately. If the patients need to be in isolation, the isolation room should have negative air pressure and a
HEPA filter. Personnel entering the room should wear gowns, gloves, shoe covers, eyewear and an N95 respirator mask.

**Notification**

All healthcare facilities should have in their disaster/emergency plans a list of people and agencies that should be contacted in the event of an attack with biological weapons. The local health department and the hospital infection control department should always be notified, and the Centers for Disease Control should also be called for guidance and information.

**Psychological Issues**

Aside from causing illness and death, one of the goals of an attack with a biological weapon would be to cause panic and confusion. The sarin gas attack in the Tokyo subway system clearly showed that not only will people who are exposed in these situations go to hospitals, but many, many others who are worried or concerned that they might have been exposed, or people who have signs and symptoms of any type will seek medical help: approximately 80% of all the people who self-referred to Tokyo hospitals were quickly examined and discharged. Both those exposed and those worried that they have been exposed will be quite scared and possibly panicked. There are many unknowns that are extremely frightening to them: What have I been attacked with, and how serious is it? Will I infect my family and friends? How effective are the treatments? Am I going to die or suffer long-term effects? Does the hospital staff know how to take care of me? There is no easy answer to this problem, but most experts agree that quickly giving concise and easy to understand information is crucial in these situations. Clearly explain what is known, what is not known, and what the risks are. Explain that there is a disaster plan in place that has been practiced and that the appropriate people and agencies have been notified. Avoid excessive and unnecessary treatments and isolation.

It is also important to recognize that although reassurance and information can be very useful in helping patients cope with their immediate fears and anxiety, an acute stress disorder is possible that can happen days or weeks after the event. Patients should be informed of this and arrangements made for immediate counseling where appropriate and for follow-up.


