

Biological Terrorist Agents Part I - Bacterial Agents

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On January 2002, anthrax was covered in detail in the Hazmat Studies column. This column will cover other potential biological agents that could be used by terrorists.

Biological terrorist agents are microorganisms or toxins derived from living organisms to produce death or disease in humans, animals or plants. Both good and bad bacteria are present in the environment and living organisms. The bad bacteria are referred to as pathogens, because they can cause death to a living organism. Pathogens, or disease-causing microorganisms, are classified as 6.2 Infectious Substances under the United Nations/U.S. Department of Transportation (UN/DOT) hazard class system. Toxins, which are poisons produced by microorganisms or plants, are classified as 6.1 Poisons.

Biological warfare agents have often been referred to as the "poor man's atom bomb" because these agents are cheap, easy to obtain and in many cases can be manufactured without detection. Use of biological weapons produces a dramatic impact; they can penetrate fortifications; have delayed effects; and produce a large number of sick and dead. Biological agents are the ideal terrorist agent, they can be highly infectious, viable and stable, easy to conceal and transport, and withstand dissemination.



Courtesy Robert Burke

If the presence of a bacterial agent has been confirmed, proper chemical protective clothing should be worn by firefighters and other emergency responders.

Potential areas affected by biological agent dissemination maybe large, due to the migration of infected individuals. Biological agents are among the deadliest substances known to man and if properly disseminated, they can kill hundreds of thousands of people.

Biological agents can be subdivided into several related groups. These include viruses, bacteria and rickettsia, and toxins. Bacteria and rickettsia are single-celled microscopic organisms that can cause disease in plants, animals and humans. Diseases caused by bacteria include anthrax, botulism, plague, cholera, diphtheria, tuberculosis, typhoid fever, typhus, Legionnaire's disease, Lyme disease and strep infections.

- ? **Viruses.** Viruses are very small, submicroscopic organisms, smaller than bacteria and are unable to live on their own. They must invade the host cell and make use of its reproductive mechanism to multiply.
- ? **Bacteria.** From 300,000 to 1 million different types of bacteria exist on the earth. The majority of common bacteria are neither pathogenic nor parasitic. Nearly all live and thrive

in nature. Some, however, have mutated and learned to invade other cells and cause disease.

- ? **Rickettsia.** Rickettsia are pleomorphic (are present in many varying sizes) parasitic microorganisms that live in the cells of the intestines of arthropods (invertebrate animals) such as insects, spiders and crabs that have segmented bodies and jointed limbs. Some are pathogenic to humans and other mammals, where they are known to cause the typhus group of fevers. Rickettsia are smaller than bacteria, but larger than viruses. Like viruses, rickettsia are obligate (they cannot exist on their own or in any other form) and they are considered intracellular parasites.
- ? **Toxins.** Toxins are poisons produced by living organisms including plants, bacteria, and animals. They would be classified as 6.1 poisons rather than 6.2 infectious substances because they are toxic materials rather than disease-causing agents.

Bacteria are single-celled organisms that may range in shape and size from cocci (spherical cells) with a diameter of 0.5 to 1 micrometer (m) to long, rod-shaped organisms – bacilli – that may be 1-5 m in size.

Bacteria have two methods by which they can cause disease in humans and animals. The first is by attacking the tissues of the host living thing. Secondly, all living organisms produce waste. Bacteria may produce a toxic or poisonous waste material that causes disease in the host. Some bacteria may attack using both methods.

Plague (*Yersinia pestis*) is a zoonotic bacterium that is normally spread among rodents by infected fleas. Zoonotic bacterium are capable of being transmitted from lower animals to humans under natural conditions. Three forms of the disease can affect humans: bubonic, pneumonic and primary septicemic. (Another type of plague, pharyngeal, resembles acute tonsillitis.)

Periodic outbreaks of the plague occur naturally in rodent populations, which may result in a high death rate. Fleas that have lost their usual hosts pursue alternative sources of blood. When this happens, the risk to humans and other animals is increased.

Epidemics of plague in humans commonly involve house rats and their fleas. Animals prone to be carriers in the United States include rock squirrels, prairie dogs and other burrowing rodents. The last plague epidemic in the United States occurred in 1924 and 1925. Since then, only isolated cases have been reported, usually in rural areas from wild rodents. Plague cases in the United States during the 1980s averaged 18 per year, mostly in Arizona, California, Colorado and New Mexico.

Death rates from bubonic plague can reach as high as 60% if victims are not treated. When victims are treated, the death rate is reduced to about 15%. If treatment is not begun within 24 hours after symptoms develop, pneumonic plague has a near 100% death rate. (Plague can also be transmitted when the organism enters the body through a break in the skin. This type of exposure occurs from direct contact with tissue or body fluids of a plague-infected animal, such as skinning a rabbit or other animal. This, however, is a rare occurrence.)

Plague can be transmitted through inhalation by contacting infected droplets from a person or domestic animal coughing. Plague that develops from this type of exposure is called pneumonic. This infection involves the lungs as a result of inhalation of organisms, which results in primary pneumonic plague. Secondary pneumonic plague results from septicemia (a blood infection) when the organisms spread to the lungs. Symptoms from plague exposure usually develop within two to six days after exposure. Pneumonic plague occurs a little faster, from one to three days, which is also dependent on the amount of organisms inhaled. Symptoms of bubonic plague include enlarged lymph nodes, fever, chills and prostration. Pneumonic plague symptoms are similar to those of bubonic plague and include high fever and chills that are accompanied by coughing and difficulty breathing, toxemia and the production of a bloody sputum. Symptoms may be followed by rapid shock and death

if treatment is not begun early. Death results from respiratory failure, circulatory collapse and a predisposition toward bleeding.

Bubonic plague can progress spontaneously to septicemic plague accompanied by fever, chills, prostration, abdominal pain, shock and bleeding into the skin and other organs. It can also affect the central nervous system, lungs and other parts of the body.

As many as 80% of bubonic plague victims have positive blood cultures for septicemia. Approximately 25% of the patients also have various types of skin lesions. Pustules, vesicles, eschars (dead tissue separating from living tissue) or papules (small elevations of the skin) containing leukocytes and bacteria may also be present near the site of the fleabite.

Antibiotic treatment should begin as soon as possible. Streptomycin is the drug of choice, but others such as tetracyclines, chloramphenicol, gentamicin or one of the sulfonamides may also be effective. A vaccine for the plague is available, but it is effective only as a preventative measure; once someone is exposed, the vaccine will not help. The initial dose of vaccine is followed by a second dose one to three months later and a third dose three to six months after that. Booster shots are administered at six, 12 and 18 months and then every one to two years. As with all vaccines, the level of protection is related to the size of the dose; vaccination defense could be overwhelmed by extremely high doses of the bacteria.

Once infected with plague through aerosol dissemination, people and animals could pass the disease to each other. Aerosol delivery would result in pneumonic plague developing in those exposed. If infected fleas are disseminated into a geographic area, bubonic plague would follow in those bitten by the fleas. The bacteria can survive in blood for 100 days and in human bodies for up to 270 days. They remain viable in water and moist meals and grains for several weeks.

Tularemia (*Francisella tularensis*), also known as rabbit fever, deerfly fever and Ohara's disease, like the plague is a bacterial infection that can occur naturally from the bite of insects, usually ticks and deerflies. The disease can also be acquired through contact with infected rabbits, muskrats and squirrels, ingestion of contaminated food or inhalation of contaminated dust. Once contracted, is not directly spread from human to human.

Tularemia remains infectious in the blood for about two weeks and in lesions for a month. The disease can occur at any time of the year, but is most common in the early winter during rabbit-hunting season and in the summer when tick and deerfly activity is at its peak. Tularemia contracted naturally has a death rate of approximately 5%. The pneumonic form, which might be precipitated by a terrorist attack, would have a much higher death rate of 30% or greater.

Tularemia can appear in several different forms in humans, depending on the route of exposure. The usual presentations are ulceroglandular, typhoidal or septicemic. In humans as few as 10 to 50 organisms can cause disease if inhaled or injected, but over 108 would be required for the disease if ingested.

Ulceroglandular tularemia is acquired naturally from dermal or mucous membrane exposures of blood or tissue fluids of infected animals. The typhoidal form makes up 5% to 15% of naturally occurring cases, which result from inhalation of infectious aerosols. Pneumonia can result from any of the forms of tularemia but is most prominent in typhoidal. Incubation periods range from two to 10 days, depending on the dose and route of exposure.

Symptoms of ulceroglandular disease include lymphadenopathy, fever, chills, headache and malaise. About 90% to 95% of patients may present cutaneous ulcers. When ulcers are absent, it is referred to as glandular tularemia. When symptoms are confined to the throat, it is called primary ulceroglandular disease. Oculoglandular tularemia results from contact to the eyes from an infected fluid or blood. Typhoidal

or septicemic tularemia produces fever, prostration and weight loss, without adenopathy (any disease of a gland, especially a lymphatic gland). Diagnosis of primary typhoidal tularemia is difficult because the symptoms are very non-specific. After exposure, the usual treatment is two weeks of tetracycline. Streptomycin is given for more severe exposures. Aminoglycosides, genatamycin, kanamycin and chloramphenicol are also effective antibiotics. Tularemia survives outside the host in carcasses and organs up to 133 days, in grain dust and bedbugs for 136 days, in rabbit meat for 31 days, in straw for 192 days, and in water for up to 90 days. A vaccine is under development and has been successful during tests on more than 5,000 people, without significant adverse reactions.

Q-Fever (*Coxiella burnetii*), also known as Query Fever, is a bacterial disease that occurs naturally in sheep, cattle and goats. It is present in very high concentrations in the placental tissues of these animals. *Coxiella burnetii* is the bacterial agent that causes Q-Fever.

Incidence of the disease is worldwide and it is likely that more cases occur than those reported. Many epidemics occur in stockyards, meat-packing plants and medical labs that use sheep in research.

Transmission occurs from airborne dissemination of rickettsiae in dust from contaminated premises. Organisms can be carried in the air over a half-mile downwind. Infections also occur from contact with infected animals, their birth products (especially sheep), wool from sheep, straw, fertilizer and laundry of exposed persons. The disease has also been traced to unpasteurized milk from cows. Transmission from human to human is very rare.

Several varieties of ticks may also carry the disease and transmit it from animal to animal. Mortality rates from this disease are very low, from 1% to 3%, though it is an incapacitating agent because it is highly infectious when delivered through inhalation. As little as one organism can cause clinical symptoms. The usual infectious dose is considered to be 10 organisms through inhalation.

Symptoms are not specific to the disease and may be mistaken for symptoms of a viral illness or atypical pneumonia. The incubation period is 10 to 20 days. Patients may experience fever, cough and chest pain as soon as 10 days after exposure.

Although rare, other symptoms that may appear include chills, headache, weakness, malaise, severe sweats, hepatitis, endocarditis, pericarditis, pneumonitis and generalized infections.

Disease	Dissemination Method	Infective Dose	Incubation Period	Lethality
Cholera	Food & Water	10 ⁶ organisms	1 week	Low when treated, high when not
Brucella	Aerosol, Food & Water	Unknown	5 to 30 Days	Very low
Plague	Aerosol	Fewer than 100 organisms	1 to 6 Days	High when not treated
Tularemia	Aerosol	1-50 organisms	1 to 10 Days	Moderate
Q-Fever	Aerosol, Food & Water	10 organisms	14 to 26 Days	Very low

Q-Fever is generally a self-limiting illness and will clear up without treatment.

Antibiotics given during the illness can shorten the period of incapacitation.

Tetracycline is the antibiotic of choice and when given during the incubation period may delay the onset of symptoms. The usual dosage is 500 mg every six hours (or doxycycline, 100 mg every 12 hours). Use of antibiotics will shorten the duration of the illness. Antibiotic treatment should be continued for five to seven days.

The disease is remarkably resistant to heat and drying and is stable under diverse environmental conditions. It can survive for months and even years in the environment. It also survives in dried sputum for 30 days, in dust for up to 120 days, in dried urine for 49 days, in the feces of ticks for 586 days, in milk for 42 months at 45 degrees Fahrenheit and in wool for 12 to 16 months, also at 45F. Vaccines for humans are in the development stages, although tests have shown promise.

Cholera (*Vibrio cholera*) is a bacterial disease contracted through the ingestion of contaminated water or food, but it does not spread easily from person to person. It can be spread through ingestion of food or water contaminated with flies, feces or vomit of patients, by dirty water or hands contaminated with feces.

Cholera is an acute infectious disease, represented by a very sudden onset of symptoms. Victims may experience nausea, vomiting, profuse watery diarrhea with a "rice water" appearance, the rapid loss of body fluids, toxemia and frequent collapse. Not everyone exposed will show symptoms. In some cases there may be as many as 400 people without symptoms for every patient showing symptoms. When cases go untreated, the death rate can be as high as 50%. With treatment, the death rate drops to below 1%.

Cholera itself is not lethal, but the breakdown of medical treatment systems in large outbreaks can result in many deaths from dehydration, hypovolemia (loss of body fluid) and shock. Fluid loss can be as much as five to 10 liters per day and IV fluids used to replenish fluids can be in short supply. The incubation period varies from 12 to 72 hours, depending on the dose of ingested organisms. An infectious dose is greater than 10⁸ organisms to a healthy individual through ingestion.

Treatment involves antibiotic and IV fluid therapy using tetracycline (500 mg every six hours for three days). Doxycycline (300 mg once or 100 mg every 12 hours for three days), IV solutions of 3.5 g NaCl, 2.5 g NaHCO₃, 1.5 g KCl and 20 g glucose per liter are also appropriate treatments. Cholera shows a significant resistance to tetracycline and polymyxin antibiotics. Ciprofloxacin (500 mg every 12 hours for three days) or erythromycin (500 mg every six hours for three days) can be used as substitutes.

Cholera is very sensitive to cold temperatures. Bacteria can remain active in dust for 3 to 16 days; feces up to 50 days; in glass up to 30 days; on metal coins for 7 days; on finger tips for 1 to 2 hours; and in soil for 16 days. It also survives well in water depending on the temperature. A vaccine is available for prevention, however it has not proven very effective. It offers only 50% protection for up to six months.

Brucella (brucellosis), also called undulant fever and Bang's disease, is a bacterial disease caused by any of four species of coccobacilli. They are naturally occurring diseases in cattle, goats, pigs, swine, sheep, reindeer, caribou, coyotes and dogs. The organisms can be contracted by humans through ingestion of unpasteurized milk and cheese or from inhalation of aerosols generated on farms and in slaughterhouses. Skin lesions on persons who have come in contact with infected animals can also spread infection. The disease is also common in populations who eat raw caribou. When the animal population has a high rate of infection, the rate of disease occurrence is also higher in humans.

The infectious dose of *Brucella* is unknown. Symptoms are nonspecific and insidious upon onset (the disease is well established when the symptoms appear). Symptoms include intermittent fever, headache, weakness, profuse sweating, chills, arthralgia and localized suppurative (pus-forming) infections are frequent. Incubation periods vary from five to 30 days, and in some cases, many months. Evidence of human-to-human transmission of the disease has not been documented. Death is uncommon even in the absence of treatment.

Treatment of brucellosis involves the administration of the antibiotics tetracycline and streptomycin or TMP-SMX. The disease is resistant to penicillin and cephalosporin. Brucellosis bacteria remains active outside a host in carcasses and organs for up to 135 days, in paper 32 days, in soil for 125 days and in blood for 180 days at 40F. No vaccine is available for use in humans.



Courtesy Robert Burke

Hospitals should be prepared to decontaminate victims of known dissemination of biological agents, the deadliest substances known to man.

Once this occurs, the lice excrete rickettsiae in their feces, which is defecated as they feed.

Infection occurs from feces left on the skin by the lice, which are rubbed in at the site of the bite or other breaks already existing in the skin, or through inhalation of infected dust. Squirrels become infected from the bite of the squirrel flea. The incubation period ranges from one to two weeks, with an average of 12 days. Rickettsia Canada cannot be transmitted directly from human to human, but it is a bloodborne pathogen, and universal precautions should be practiced. Infection remains in the louse for two to six days after biting the source, although it may occur quicker if the louse is crushed.

Symptoms include headache, chills, fever, prostration and general pains. On the fifth or sixth day, a macular eruption (unraised spots on the skin) occurs on the upper trunk and spreads to the entire body (except for the face, palms of the hands and soles of feet). The illness lasts for approximately two weeks. Without treatment, the fatality rate is about 10% to 40%. Treatment involves antibiotic therapy with tetracyclines and chloramphenicol.

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Rickettsia are pleomorphic (found in many varying sizes) parasitic microorganisms. A number of strains of these bacteria exist naturally. Rickettsia Canada, also known as louse-borne typhus fever and classical typhus fever, occurs in areas of poor hygiene that are also louse-infected. Outbreaks generally occur in Central America, South America, Asia and Africa. The last epidemic in the United States occurred in 1921. It is primarily a disease of humans and squirrels. The body louse, *Pediculus humanus*, is the primary carrier of the disease. It feeds on the blood of an infected patient with acute typhus fever and becomes infected.