

Biological Terrorist Agents: Part 2 – Viral Agents

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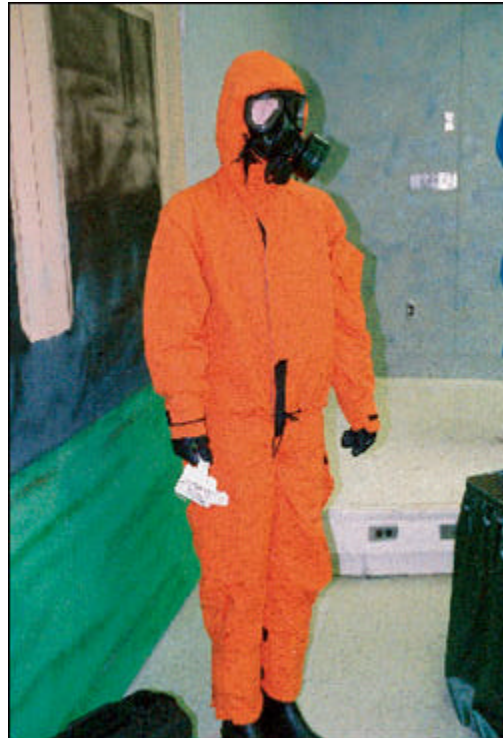
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Viruses are the simplest type of microorganisms and the smallest of all living things. They are much smaller than bacteria and range in size from 0.02 to 1 micron (one micron equals 1,000 millimeters). One drop of blood can contain over 6 billion viruses! Viruses were discovered in 1898 and observed for the first time in 1939. Virus is a Latin word meaning “poisonous slime.”

Every living entity is composed of cells, except for viruses, which are totally inert until they come in contact with a living host cell. Hosts can include humans, animals, plants or bacteria. The infection point created from the virus occurs at the cellular level. There must be an exact fit between the virus and the cell or the invasion of the cell cannot occur.

Viruses are unable to exist by themselves; they must find a suitable host cell in order to attach and thrive. After a virus attaches to a cell, the virus begins to reproduce itself, resulting in an acute viral infection. Viruses can also be cultivated on chorioallantoic membranes (fetal membrane) from fertilized eggs. Cultivating viruses in this manner is very expensive and time consuming. Once a virus takes hold of the cell, it can cause the host cell to die.

Common examples of viral agents include measles, mumps, meningitis, influenza and the common cold. Viruses that most people are familiar with today are HIV (the virus that causes AIDS) and HBV (the virus that causes hepatitis B). Neither would be very effective terrorist agents because of the long incubation period and contraction methods required of AIDS, and the low lethality of the HBV virus. These viruses are not airborne and are usually very difficult to transmit. Very specific actions have to take place to transmit the viruses. HIV and HBV are transmitted by contact with blood and body fluids. They are more commonly referred to as bloodborne pathogens.



Courtesy Robert Burke

Special protective equipment is required for personnel responding to incidents suspected of involving viral agents.

More likely virus candidates for terrorist agents would include Venezuelan equine encephalitis (VEE), smallpox and those that cause hemorrhagic fevers. Viral hemorrhagic fevers are a group of viruses that include Ebola, Marburg, Arenaviridae, Lassa fever, Argentine and Bolivian, Congo-Crimean, Rift Valley, Hantavirus, yellow fever and dengue.

Smallpox is a lethal infection caused by the variola virus, which has at least two strains, variola major and variola minor. Cases of smallpox date back over 2,000 years, and it is the oldest known human pathogen. Conquistadors brought the disease from Spain to the New World in the 1700s and it was transmitted to the Native Americans, which wiped out over 90% of that population over the next 100 years. It is believed that Ramses V, the Egyptian pharaoh who died in 1157 BC may have had smallpox pockmarks on his mummified face.

Naturally occurring smallpox was declared eradicated from the earth in 1980 by the World Health Organization (WHO), a branch of the United Nations. The last reported case in the world occurred in Somalia in 1977. Two laboratories hold the last known stocks of variola virus, the U.S. Centers For Disease Control (CDC) in Atlanta and VECTOR in Novizbersk, Russia. Clandestine stocks could exist in other parts of the World, but are as yet unknown. If they do exist, smallpox could come into the hands of terrorists and be used as a biological weapon. The WHO's governing body has recommended destruction of the remaining stockpiles.

An effective vaccination is available for smallpox and has been used for years for the general population. Since it is primarily a children's disease, vaccinations were given during early childhood and were effective for only about 10 years. Vaccination of civilians in the United States was discontinued in the early 1980s, although some military forces vaccinated until 1989 and members may still retain some immunity. Children, who are no longer vaccinated, would be at great risk from exposure to smallpox. Monkey pox and cowpox are closely related to variola and might be genetically manipulated to produce a smallpox-like virus.

Once exposure to the smallpox virus occurs, the incubation period is approximately 12 days. Those who may have contacted exposed persons are quarantined for a minimum of 17 days following the exposure. Symptoms of smallpox include malaise, fever, rigors (chills and severe shivering), vomiting, headache and backache; about 15% of patients develop delirium (hallucinations). In approximately two to three days, an enanthem develops concomitantly with a particular rash on the face, hands and forearms. This is followed by eruptions on the lower extremities and the trunk of the body, which occurs over a week's time. Lesions progress from discolored spots flush with the surface of the skin to raised spots, then finally to an inflamed swelling on the skin containing pus (skin blisters). Lesions are more abundant on the extremities and face, which is important in the diagnosis of the disease. Within eight to 14 days, scabs form on the skin blisters. Once the scabs fall off, a discolored depression is left behind. As long as the scabs are in place, the patient is considered contagious and should be isolated.

An outbreak of smallpox would be a true international emergency and should be reported to public health officials. Few if any people in the general population have effective vaccinations against the disease. Transmission occurs from close person-to-person contact and it is unknown whether an airborne dispersion would be effective.

Most antiviral drugs for smallpox are experimental at present and would not be available for large numbers of victims. Vaccinia-immune globulin (VIG) has shown to be an effective prevention following an exposure to smallpox. It is recommended that 0.6 ml/kg of body weight be given to the victim intramuscularly within 24 hours of exposure. The U.S. military has a limited supply of VIG.

Venezuelan equine encephalitis is a virus that is transmitted from horse to horse in nature by mosquitoes. Humans can also get VEE from an infected mosquito. Each year, thousands of people acquire the disease naturally from mosquito bites. Human outbreaks usually follow an epidemic among the horse population. Humans who are infected can infect mosquitoes for up to 72 hours. Once a mosquito becomes infected, it remains so for life. VEE is considered to be a bloodborne pathogen.

Universal precautions for bloodborne pathogens should be taken by emergency workers when around the VEE patient. Human-to-human transmission through inhalation of respiratory droplets theoretically can cause infection, but has not been proven. For VEE to be an effective biological weapon, it would have to be aerosolized.

VEE is rarely fatal (less than 1% of cases) and acts as an incapacitating agent. Nearly 100% of those exposed acquire the disease; however, only a small number actually develop encephalitis. Young children are the most vulnerable for developing encephalitis. VEE is characterized by convulsions, coma and paralysis.



Courtesy Robert Burke

Firefighter turnout gear would provide a high degree of protection against the presence of unknown biological agents.

Encephalitis is characterized by inflammation of the meninges (surrounding membranes) of the brain and the brain itself, which produces central nervous system symptoms. The onset of symptoms is sudden, following an incubation period of one to five days. Symptoms are flu-like and may include malaise, spiking fevers, rigors, severe headache, photophobia (sensitivity to light) and myalgias (muscle pain). Symptoms of VEE may include nausea, vomiting, cough, sore throat and diarrhea. Complete recovery requires one to two weeks.

Diagnosis of VEE is difficult, as the physical symptoms are non-specific. White blood cell counts may show a striking leukopenia (abnormally low leukocytes in the blood) and lymphopenia (reduction in number of lymphocytes circulating in the blood). The virus can be isolated from the serum (fluid that forms blood clots). Because there are no drugs or specific treatments for the disease, treatment is supportive. Analgesics may be given to relieve headache and myalgia. Victims who develop encephalitis can be treated with anticonvulsants and fluid therapy for electrolyte balance.

Two vaccines are available, but are still in the investigation phase of development. TC-83, a live vaccine, is given in a single dose 0.5 ml subcutaneously. A second vaccine, C-84, is used to boost those who do not respond to the TC-83. It is given 0.5 ml subcutaneously in three doses at two- to four-week intervals. Research is also underway using antiviral drugs that have shown some promise with laboratory animals. However, no human clinical data is available. The VEE virus remains active

outside the host in pharyngeal secretions, dried blood and exudates (fluids from wounds or pores of the skin).

Viral hemorrhagic fevers (VHFs) are an assorted group of human diseases originated by viruses from several different families. Included are the filoviridae family, which includes Marburg and Ebola; and the Arenaviridae family, which encompasses Lassa fever, Argentine and Bolivian hemorrhagic fevers. Other groups are the Bunyaviridae family, which involves various members of the Hantavirus genus; the Congo-Crimean hemorrhagic fever family from the Nairovirus genus; and the Rift Valley fever from the Phlebovirus genus. The last family is the Flaviviridae, which includes yellow fever and the dengue hemorrhagic fever virus.

The Ebola virus first appeared in 1976 in the African states of Sudan and nearby Zaire. Another outbreak occurred in Zaire in 1979. Again in 1995, there were 316 cases of Ebola reported in Kikwit, Zaire, which are believed to have resulted from one person. The virus spreads through close personal contact with a person who is infected with the disease and can also be spread through sexual contact. Universal bloodborne pathogen precautions should be practiced when treating victims. It is not known what the natural host is for the virus or how a person contracts the disease initially. The incubation period is two to 21 days. It survives outside the host for up to two weeks in blood specimens, but does not survive long when dried out. Mortality rates in Africa from Ebola range from 50% to 90% of those infected. Another strain of Ebola, the Reston, was reported among monkeys in the Philippines in 1989. This strain is not yet known to transmit to humans. African strains, on the other hand, have caused severe disease and death.

Why the disease has only shown sporadic outbreaks is unknown. Marburg virus has been reported to have caused infection in man on four occasions. Three occurrences were in Africa and one in Germany, where the virus was named. Outbreaks first occurred in Germany and Yugoslavia involving 31 reported cases, which occurred from exposure to African green monkeys. Seven people died.

The incubation period for Marburg is three to seven days. It can survive in blood specimens for two weeks at room temperature, but does not survive long when dried out. Methods of transmission are not well known. It is a bloodborne pathogen and universal precautions should be used when treating victims. The disease is spread by direct contact with infected blood, secretions, organs or semen.

Argentine hemorrhagic fever (AHF) is caused by the Junin virus, which first appeared in 1955 among corn harvesters in Argentina. The virus is spread naturally from contact with the infected excreta of rodents. Between 300 and 600 cases of AHF occur each year in the Pampas region of Argentina. A similar disease, Bolivian hemorrhagic fever, which is caused by the Machupo virus, appeared in northeastern Bolivia following the appearance of AHF. Another closely related virus is Lassa, which occurs over much of western Africa.

Congo-Crimean hemorrhagic fever (CCHF) is a disease carried by ticks and transmitted by bites to humans. Infections occur primarily in the Crimea and other parts of Africa and in Europe and Asia. The incubation period is three to 12 days. It is stable in blood up to 10 days at 105 degrees Fahrenheit. Rift Valley fever also occurs only in Africa and results in sporadic widespread epidemics of the disease.

Hantavirus was first identified prior to World War II along the Amur River in Manchuria. United Nations troops reported the occurrence of the disease during the Korean conflict in the early 1950s. The disease has also been reported in Japan, Korea and China since the war. Incubation periods vary from five to 42 days, with 12 to 16 days being the average. The virus can survive outside the host in storage for two to eight years if isolated from cells that have an immunologic function, but it is sensitive to drying.

Yellow fever and dengue fever are two diseases that are transmitted by infected mosquitoes. Yellow fever has an incubation period of three to six days. It does not survive outside the host. Yellow fever is the only one of the VHFs for which a vaccine is available. The dengue fever virus has an incubation period from three to 14 days, with seven to 10 being the average. The virus is stable in dried blood and exudates up to two days at room temperature.

All VHFs except for dengue fever are capable of being spread by aerosolization and skin crawling insects. Patients infected with VHFs other than Hantavirus will have the virus in the blood and it can be transmitted through contact with blood or body fluids containing blood. Bloodborne pathogen precautions should be undertaken when exposure to blood is a possibility. Routes of infection for the filoviruses in humans is not well understood.

VHFs are feverish illnesses that are complicated by easy bleeding, petechiae (bleeding under the skin), hypotension (abnormally low blood pressure), shock, flushing of the face and chest, and edema (excess fluid in tissues). Diagnosis will involve the patient's history of travel, as well as a high level of suspicion. VHFs should be suspected in any patient having a severe fever-type illness and signs of vascular association. This is important if the victim has traveled to an area where the virus is known to occur or where intelligence information indicates a biological warfare threat. Not all infected humans develop VHFs. The reason for this is not well understood. Congenital symptoms such as malaise, myalgias, headache, vomiting and diarrhea may appear in association with any of the hemorrhagic fevers.

Diagnosis relies on particular virologic (study of viruses and virus diseases) techniques for each virus. Treatment is supportive of the symptoms that are presented. Ribavirin may be an effective antiviral therapy for Lassa fever, Rift Valley fever and Congo-Crimean hemorrhagic fever viruses. During recovery, plasma may be effective in Argentine hemorrhagic fever.

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