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Ebola: A Significant Threat as an Infectious Disease, and as a Potential Bioterrorism Agent

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Ebola: A Significant Threat as an Infectious Disease

Ebola virus infection is a significant threat to humans and animals. Its origin, the disease it causes, spread of the disease, and the risk of bioterrorism are discussed in this article. The Ebola virus originates from Africa, with the risk of spreading worldwide by emigration, travelling, and transportation of animals (1, 2, 3). It has been predicted that global warming will ease the spread of the Ebola virus worldwide (4). There are mainly 2 threats from the Ebola virus. First, it causes an infection that is often fatal for humans and animals (2, 3). Second, there is a potential that the Ebola virus could be used as a bioterrorism agent (5).

A general overview of Ebola disease has been provided in the review articles by Bruce and Brysiewicz (2002), and Colebunders and Borchert (2000). Ebola disease is also known as hemorrhagic fever. It is a disease with hemorrhage bleedings, and high temperature. It is seen in humans and nonhuman primates. Nonhuman primates include monkeys, gorillas, and chimpanzees. The term 'Ebola' originates from the Ebola River in the Democratic Republic of Congo, formerly known as Zaire. In 1976 the first human outbreak of this virus infection occurred in the region of the Ebola River. The Ebola infection is a very severe one. It causes death in up to 90% of infected patients. Few patients can survive this dangerous infection. These are similar for the affected animals (2, 3). Therefore, Ebola infection is a significant threat to humans and animals.

Data on outbreaks of Ebola disease were given in the articles by Bruce and Brysiewicz (2002) and Colebunders

and Borchert (2000), and in a recent internet report (6). Following the first event in the region of the Ebola River several other Ebola virus outbreaks occurred in Sudan, Gabon, Uganda, and Ivory Coast, both in animals and humans. Later, in 1989, the Ebola virus was discovered in Reston, Virginia, USA, in monkeys (2). The monkeys had been imported from the Philippines, but it could not be identified how the Ebola virus had been transported to the Philippines. The virus caused serious illness in the monkeys. However, it did not cause disease in humans. A recent outbreak of the disease was reported by the Ministry of Health of the Republic of the Congo on 24 December, 2003. They had a total of 35 human cases resulting in 29 deaths (6). Thus, many human outbreaks of the Ebola virus have occurred to date. The virus discovered in the USA did not affect humans. These data suggest that the Ebola virus usually affects both humans and animals; however, there may be events that only affect animals.

Filoviruses make up the virus family that Ebola belongs to. Their effects in humans were studied by Murphy (7). Dr. Murphy, a world authority on viruses, was the first doctor to look at the Ebola virus 'face-to-face' under the electron microscope. Therefore, the first photograph of the Ebola virus was taken by Dr. Murphy. In the reviews by Bruce and Brysiewicz (2002) and Colebunders and Borchert (2000) it has been mentioned that filoviruses are extremely harmful to humans and animals. They cause bleeding in the body, leading to death. Three types of Ebola viruses (Zaire, Sudan and Reston) are more dangerous than the fourth type, called the Marburg virus. Therefore, these 3 types of Ebola viruses are very serious threats to humans and animals.

Laboratory findings of the Ebola virus were given by Bruce and Brysiewicz (2002), and Colebunders and Borchert (2000). The microscopic structure of the Ebola virus consists of a single strand made of RNA. It easily duplicates to form new viruses. Direct detection of the Ebola virus can be done using several laboratory techniques. These include ELISA testing, polymerase chain reaction, and virus isolation. The mature virus releases large numbers of virions (viral particles) that can be seen on electronmicroscopic inspection of the blood of the patients during the acute stage of infection. These viral particles can also be seen by biopsy or autopsy. Large amounts of the Ebola virus are usually present in the skin. Therefore, a skin biopsy can be used to confirm Ebola infection.

Bruce and Brysiewicz (2002), and Colebunders and Borchert (2000) mentioned that the Ebola virus is transmitted through contact with infected patients or primates. During outbreaks, the virus appears to be transmitted by close physical contact with infected persons, their clothing, and their body fluids including blood, vomitus, stools, saliva, and sweat. The risk of transmission from patients to other persons or to the hospital staff varies significantly. The chances the virus may be transmitted from a patient to nearby persons in the early stages of the disease is lower. The chances of transmission increase when there has been contact with a patient in the later stages of illness (2, 3). These data suggest that normal persons or hospital staff who come into contact with the patients, especially with those in the late stage of the infection, are at great risk of becoming infected with the Ebola virus.

Clinical findings are variable in Ebola infection (2, 3). According to Bruce and Brysiewicz (2002), the Ebola virus has an incubation period of 2–21 days. Colebunders and Borchert (2002) mentioned that the incubation period is between 4 and 10 days. The onset of Ebola begins with symptoms that resemble a cold or influenza. Within a few hours, the body temperature rapidly rises (fever). The patients develop fatigue, muscle pain, and headaches. They experience cough, difficulty in swallowing, nausea, vomiting, and abdominal pain. They have eye problems, which is an early clinical sign. A skin rash may appear. The general condition of the patient deteriorates rapidly. Within 48 h, any movement of the eyes, jaw or head causes pain. Bleeding starts. Blood comes out from the patient's mouth, anus, eyes and ears. Bleeding is a definitive sign of the presence of Ebola disease. This also shows that death is close. Therefore, by the time the disease is diagnosed, it is too late. The

patient develops shock, convulsions (seizures) and coma. Death generally occurs 6–9 weeks after the first symptoms appear (2, 3). In summary, Ebola infection starts with mild signs resembling a cold; therefore, it might be perceived as an insignificant disease. In the later stages, severe bleeding occurs, which is a definitive sign of the disease.

Several precautions are recommended for the care of patients with Ebola disease (2). During patient care the hospital staff gives drugs and injections to the patient for symptomatic treatment. Symptomatic treatment means that the drugs are given for the complaints of the patient. Otherwise, such drugs usually do not cure the disease. First, patients should be placed in isolated rooms. All staff members must wash their hands during patient care activities and after contact with blood, body fluids, and other contaminated items. All staff members must wear gloves. Gloves must be removed after use and before leaving the patient's environment, followed by immediate hand washing. They must wear masks and eye protection or face shields during patient care. They must wear clothing that prevents contact with the virus during patient care activities. Patient equipment and linen must be appropriately cleaned, and disinfected. Disposable items are preferred. The isolation area must be a private room, and the door must be kept closed at all times with strict access control (2). In summary, the Ebola virus is an important threat to the hospital staff, and while taking care of Ebola patients all staff should do their best to protect themselves and others from the infection.

There are a few treatment possibilities for Ebola. Bruce and Brysiewicz (2002) mentioned that Ebola virus infection is among Africa's top killer diseases, and approximately 90% of the patients die, even with the most sophisticated health care. The virus is highly contagious, and no vaccination or cure is available yet (2, 3). However, Geisbert and Jahrling (2003) mentioned in their recent article that there are efforts to develop an efficacious vaccine against Ebola. Bruce and Brysiewicz (2002), and Colebunders and Borchert (2000) mentioned that treatment is only symptomatic, that is, drugs are given for the complaints of a patient. They do not cure the disease. Some patients (10% and more) can survive Ebola infection. In surviving patients healing is slow. They feel fatigue, and muscle and bone pain. Eye infection, and hearing loss are seen. In summary, in Ebola infection, treatment is only symptomatic. There is neither cure nor vaccination and few patients can survive. Therefore, the Ebola virus is a real danger.

It has been mentioned that spread of the Ebola virus is rapid, and prevention possibilities are limited (1). Bruce and Brysiewicz (2002), and Colebunders and Borchert (2000) also mentioned that the spread of Ebola virus occurs rapidly. Environmental factors are important for the spread of the virus. These include climatic conditions, sanitation, and socioeconomic factors. Outbreaks occur mostly in forests during the rainy season. However, the natural reservoir of Ebola is still unknown. Currently it is considered that mice or shrews, and certain plants whose reproductive cycles are directly linked to weather patterns might account for the natural reservoir (4). On the other hand, there is evidence that patients become with Ebola infected through contact with an infected animal. In the outbreaks, dead chimpanzees and gorillas were found in the forests. People of low socioeconomic status with limited access to health care are more likely to be infected than the social elite. Sodhi (1996) mentioned that prevention measures are limited. Because of international travel and immigration, doctors should be aware of the signs of Ebola disease. It is important that doctors must be able to recognize a case of Ebola as soon as possible when they meet the patient. They must have sufficient knowledge about laboratory tests on viruses. Doctors already have experience with adequate preventive measures for AIDS and hepatitis. This experience would help in Ebola cases (1). Researchers generally agree that besides the Ebola infections occurring in Africa the most important health threat is spread of the virus infection worldwide by emigration, travelling, and transportation of animals (1, 2, 3). In summary, the Ebola virus spreads rapidly and its spread worldwide poses an important threat to human and animal health.

Ebola: A Significant Threat as a Potential Bioterrorism Agent

Bioterrorism is a criminal act in which terrorists intentionally use harmful means against human beings (5). There are different kinds of harmful means. These include viruses, bacteria or chemicals. The aim of bioterrorists is to threaten the community with death or illness. Bioterrorism not only involves humans but also the environment including animals and plants. The threat may come from some countries and terrorist organizations. Some rogue countries develop bioweapon programs, as it is relatively cheap to do so, compared to

sophisticated weapons such as nuclear ones. Fortunately, there is a low risk of a bioterrorist attack; as it is not easy to prepare, keep, and use bioterrorism weapons. Generally, there is a low risk of a bioterrorism attack, however, if an event did occur there would be severe consequences (5).

It has been reported that there are only a limited number of biological agents that could cause a serious threat of widespread illness and death (5). The biological agents most likely to be used as weapons include *Bacillus anthracis*, causing anthrax; *Brucella species*, causing brucellosis; *Clostridium botulinum*, causing botulism; *Yersinia pestis*, causing plague; *Francisella tularensis*, causing tularemia; *Variola*, causing smallpox; and finally viral diseases such as Ebola (5).

Polesky and Bhatia (2003) claim the Ebola virus has a potential to be used as a bioterrorism agent. Geisbert and Jahrling (2003) claim that there is a threat that Ebola can be used in bioterrorism, and stated that the former Soviet Union was evaluating the Ebola virus as a weapon. Geisbert and Jahrling (2003) also mentioned that there has been little commercial interest in developing an Ebola virus vaccine; however, with the heightened awareness of bioterrorism after events surrounding September 11, the perspectives regarding the need for a vaccine against the Ebola virus have dramatically changed. As the Ebola virus could be prepared as a bioterrorism weapon, a vaccine is certainly needed.

Biological weapons could be spread in several ways, namely by contamination of food and water supplies, and by breathing of aerosols. Aerosols would be more dangerous than others, as they would be more effective in disseminating a large quantity of the harmful agent to cause mass casualties in an area (5). The most convincing experiment that the Ebola virus has a potential to be used as a bioterrorism agent was performed by (Johnson et al., 1995). They gave the Ebola virus to rhesus monkeys by inhalation and the monkeys got the infection. They mentioned that the demonstration of fatal aerosol transmission of the Ebola virus in monkeys reinforces the importance of taking appropriate precautions to prevent its potential aerosol transmission to humans (8). This reveals that the possibility of aerogenic infection using the Ebola virus is an important threat

An important issue is how bioterrorism can be detected. It has been stated by the South Dakota

Department of Health that a possible bioterrorist attack may be announced beforehand, or may be unannounced. When a terrorist group or a terrorist country announce their intent or deed beforehand, public health and law enforcement agencies as well as primary health care providers should be on alert. On the other hand, there always is the risk threat that an attack with a bioterrorist weapon can happen without any announcement from a terrorist group or country. It has been mentioned by the South Dakota Department of Health that when such an unannounced event occurs it should be detected by private health care providers, and infection control and/or public health surveillance. In this condition, the event would be the occurrence of an unusual disease and death in the community. Prompt recognition and reporting is important to prevent spread of the biological agent, and to control the number of future victims in the community (5). These data suggest that there is a significant risk that the Ebola virus can be used with aerosols in bioterrorism.

Bronze and Greenfield (2003) considered the treatment options for diseases due to potential viral agents of bioterrorism. They have given examples of how well-known biological agents can be treated. The drug named cidofovir has shown significant promise in animal models to treat smallpox and viral hemorrhagic fever. However, the application of this drug in humans is limited. Still there are reports of some human cases in whom cidofovir was applied, and the results were encouraging. Bronze and Greenfield (2003) mentioned that there is another drug, ribavirin, which has been used

to treat some hemorrhagic fever viral infections. As is known, Ebola infection is in the same category as hemorrhagic fever viral infections. Although ribavirin has the capacity to treat some hemorrhagic fever viral infections, it has been shown that the drug does not have any positive effect on Ebola infection. Bronze and Greenfield (2003) also mentioned that also there are genetic studies on the viruses that may provide valuable information for treatment and prevention strategies. However, currently there is no effective drug or genetic data for the treatment or prevention of the Ebola virus.

In conclusion, the Ebola virus poses 2 important threats to humans and animals: as an infection, and as a bioterrorism agent. Ebola infection is very serious, and is often fatal. Ebola infections are generally confined to Central Africa; however, there is always a risk of spreading to the rest of the world. Furthermore, the Ebola virus could be used as a bioterrorism weapon. These threats are enhanced as currently no effective treatment is available for the virus. Therefore, people should be aware of the threats from the Ebola virus in order to avoid infection, and scientists should try their best to develop a treatment and vaccination.

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