Title: Ebola virus.

Authors: Ghayourmanesh, Soraya, PhD
         Hawley, H. Bradford, MD


Document Type: Article

Subject Terms: Ebola virus disease
               Virus diseases
               Hemorrhagic fever
               Ebola virus

Abstract: The Ebola virus is named after the Ebola River in the Democratic Republic of the Congo in Central Africa. The virus was first detected in 1976, when hundreds of deaths were recorded in Zaire (now the Democratic Republic of the Congo) as well as in neighboring Sudan. Four species of the Ebola virus genus cause human disease: Zaire ebolavirus (EBOV), Sudan ebolavirus (SUDV), Bundibugyo ebolavirus (BDBV), and Taï Forest ebolavirus (TAFV). A fatal disease among cynomolgus laboratory monkeys that were imported from the Philippines to Texas in 1996 was caused by the Reston ebolavirus (RESTV) subtype, which causes disease in nonhuman primates and in pigs but is not known to cause symptoms in humans. Another devastating outbreak among humans took place in early 1995 in Kikwit, Zaire, claiming the lives of 250 out of 315 reported patients, an 88 percent fatality rate. The epidemic ended within a few months, as suddenly as it began; this puzzled scientists, who are still not fully aware of the causes and nature of the virus. Despite the dreadful speed with which the disease killed its victims, scientists were able to contain it with a relatively small number of fatalities.

Full Text Word Count: 2314

Accession Number: 86194072

Database: Research Starters

Ebola virus

Anatomy or system affected: Blood, circulatory system, gastrointestinal system, muscles, skin

Definition: A virus responsible for a severe and often fatal hemorrhagic fever

Causes: Viral infection

Symptoms: Severe blood clotting and hemorrhaging, fever, lethargy, appetite loss, headaches, muscle aches, skin rash

Duration: Acute

Treatments: None

Causes and Symptoms
The Ebola virus is named after the Ebola River in the Democratic Republic of the Congo in Central Africa. The virus was first detected in 1976, when hundreds of deaths were recorded in Zaire (now the Democratic Republic of the Congo) as well as in neighboring Sudan. Four species of the *Ebolavirus* genus cause human disease: *Zaire ebolavirus* (EBOV), *Sudan ebolavirus* (SUDV), *Bundibugyo ebolavirus* (BDBV), and *Tai Forest ebolavirus* (TAFV). A fatal disease among cynomolgus laboratory monkeys that were imported from the Philippines to Texas in 1996 was caused by the *Reston ebolavirus* (RESTV) subtype, which causes disease in nonhuman primates and in pigs but is not known to cause symptoms in humans. Another devastating outbreak among humans took place in early 1995 in Kikwit, Zaire, claiming the lives of 250 out of 315 reported patients, an 88 percent fatality rate. The epidemic ended within a few months, as suddenly as it began; this puzzled scientists, who are still not fully aware of the causes and nature of the virus. Despite the dreadful speed with which the disease killed its victims, scientists were able to contain it with a relatively small number of fatalities.

Outbreaks of Ebola hemorrhagic fever in Africa have continued to occur, some of them severe. A 2007 outbreak in the Democratic Republic of the Congo resulted in 264 cases and 187 deaths. Starting in February 2014, several West African countries were hit by the largest outbreak to date, with 28,652 reported cases (both confirmed and suspected) and 11,325 deaths as of April 2016. Between September and October 2014, one man who had traveled to the United States from Liberia tested positive for Ebola and passed away days later; a handful of health care workers, including two who had been treating the Ebola patient at the hospital in Texas and two who had been missionary workers in Liberia, tested positive for the disease but recovered in the United States. Liberia, Sierra Leone, and Guinea were the hardest hit by the 2014 Ebola outbreak. The outbreak in Sierra Leone was declared to have ended in March 2016, forty-two days after the last cases provided consecutive negative blood samples and were discharged. New cases of Ebola virus continued to be reported in Liberia and Guinea into 2016.

Two more deadly Ebola outbreaks occurred in 2018 in the Democratic Republic of the Congo. The first, which was reported in May, was located in the province of Equateur and involved fifty-four confirmed or probable cases that resulted in thirty-three deaths, according to the World Health Organization (WHO), which declared that the outbreak had ended in July. By August, the beginning of a second outbreak had been reported, this time in the province of North Kivu. As of early February 2019, according to WHO, there had been over 780 total cases and more than 480 deaths.

A transmission electron micrograph of the Ebola virus.
Centers for Disease Control and Prevention (CDC)

The Ebola virus appears to have an incubation period of two to twenty-one days, with an average of four to twelve days, after which time the impact is devastating. The patient exhibits appetite loss, increasing fever, headaches, and muscle aches. The next stage involves disseminated intravascular coagulation (DIC), a condition characterized by both blood clots and hemorrhaging. The clots usually form in vital internal organs such as the liver, spleen, and brain, with subsequent collapse of the neighboring capillaries. Other symptoms include vomiting, diarrhea with blood and mucus, and conjunctivitis. An unusual type of skin
irritation known as maculopapular rash first appears in the trunk and quickly covers the rest of the body. The final stages of the disease involve mucosal hemorrhaging (typically from the gastrointestinal tract), coupled with shock, hypotension, and multiple organ failure, and typically death due to shock and organ failure within six to sixteen days after infection. Survivors continue to report physical symptoms, including joint and muscle pain, headache, and visual problems, at least four months after the resolution of acute disease.

Treatment and Therapy

The Ebola virus is classified as a ribonucleic acid (RNA) virus and is closely related to the Marburg virus, first discovered in 1967. Ebolavirus and Marburgvirus are two of only three identified genera in the Filoviridae family, which was first officially established in 1987; the third, Cuevavirus, was only added in 2013.

Electron microscope studies show the Ebola virus as long filaments, 650 to 14,000 nanometers in length, that are often either branched or intertwined. Its virus part, known as the virion, contains one single noninfectious minus-strand RNA molecule and an endogenous RNA polymerase. The lipoprotein envelope contains a single glycoprotein, which behaves as the type-specific antigen. Spikes are approximately seven nanometers in length, are spaced at approximately ten-nanometer intervals, and are visible on the virion surface. It is believed that once in the body, the virus produces proteins that suppress the organism's immune system, thus allowing its uninhibited reproduction.

In 2002, researchers announced a new discovery about how Ebola enters and subverts human cells. Findings show that the virus targets "lipid rafts," tiny fat platforms that float atop the membranes of human cells. These rafts act as gateways for the virus, the assembly platform for making new virus particles, and the exit point where new particles bud. This research is a significant step toward one day creating drugs that will stop viruses from replicating.

The Ebola virus can be transmitted through contact with body fluids, such as blood, semen, mucus, saliva, urine, and feces. It is thought that the first person in an outbreak acquires the virus through contact with an infected animal, including carcasses of dead animals. In early 2015, researchers for the National Institutes of Health conducting a study on macaque monkeys determined that the virus can remain infectious in a corpse for up to one week, and it can still be detected for close to ten weeks. Ebola virus has been isolated from the semen of male survivors several weeks after symptom onset.

The level of infectivity of the Ebola virus is quite stable at room temperature. Its inactivation is accomplished via ultraviolet or gamma irradiation, 1 percent formalin, beta propiolactone, and an exposure to phenolic disinfectants and lipid solvents, such as deoxycholase and ether. The virus isolation is usually achieved from acute-phase serum of appropriate cell cultures, such as MA-104 cells from the kidney cell line of fetal rhesus monkeys. Satisfactory results have been accomplished using tissues obtained from the liver, spleen, lymph nodes, kidneys, and heart during autopsy. Virus isolation from brain and other nervous tissues, however, has been rather unsuccessful so far. Neutralization tests have been inconsistent for all filoviruses; Ebola strains show cross-reactions in tests of immunofluorescence assays.

There appears to be no known or standard treatment for Ebola fever. No chemotherapeutic or immunization strategies are available, and no antiviral drug has been shown to provide positive results, even under laboratory conditions. There is indirect evidence that convalescent blood transfusions may improve survival rates among patients, and certain monoclonal antibodies and RNA interference (RNAi) therapies have shown some effectiveness in nonhuman primates. Antimalarial therapy with artesunate-amodiaquine was associated with a reduced risk of death in patients with Ebola. During the 2014 outbreak, the monoclonal antibody ZMapp was given to several infected patients with mixed but potentially promising results.
Aside from experimental treatments, therapy for Ebola patients involves aggressive supportive care focused on sustaining the desired fluid and electrolyte balance by the frequent administration of fluids. Bleeding may be fought off with blood and plasma transfusion. Hemodynamic support, reversal of coagulopathy, and the treatment of any secondary infections are also used in the treatment of patients with Ebola. Some patients may require renal replacement therapy. Sanitary conditions to avoid further contact with the disease are essential. Proper decontamination of medical equipment, isolation of the patients from the rest of the community, and prompt disposal of infected tissues, blood, and even corpses limit the spread of the disease.

**Perspective and Prospects**

The puzzling characteristics of the Ebola virus are the location of its primary natural reservoir, its sudden eruption and quick end, its high mortality rate, and the unusual discovery of the virus in the organs of people who have survived it.

In the past, experimental work on the virus has been slow because of its high pathogenicity. The progress of recombinant deoxyribonucleic acid (DNA) technology has shed the first light on the molecular structure of this virus. It is hoped that further work using this technique as well as results from viruses of lower pathogenicity, such as the Reston virus, will provide the desired information on replication and virus-host interactions. Finally, the improvement of the various diagnostic tools will allow more accurate virus identification and assessment of transmission modes.

In 1995, investigators and epidemiologists from WHO captured about three thousand birds, rodents, and other animals and insects that were suspected of spreading the disease in order to investigate the source of the virus. The results were obscure and inconclusive, with the exception of the established link between primates and Ebola virus infection in humans. This conclusion was reached after a researcher in Côte d’Ivoire contracted the Tai Forest virus in 1994 after performing an autopsy on an infected chimpanzee. This was the first—and, as of 2019, only—known human case of the Tai Forest subtype, which was subsequently named for the Tai National Park forest reserve in Côte d’Ivoire where the researcher had been working. The infection ultimately proved nonfatal.

Despite this evidence, however, the human outbreaks in the Democratic Republic of the Congo, Sudan, and West Africa have not been traced to primates. Certain species of fruit bat are suspected to be a natural source of the disease. Just in 2018, researchers examining bats in Sierra Leone hoping to definitively determine the hosts of such viruses as Ebola discovered yet another strain of the Ebola virus. Referring to the new virus as the Bombali virus as it was found in bats located in the Bombali district, scientists found through laboratory analysis that while the virus had proven able to penetrate human cells, it was not clear whether it was capable of causing illness in humans. While this evidence gave further credence to the theory that bats may be the most likely source of the Ebola virus, the mammals could still not be officially declared as the hosts at that point. As long as these puzzling questions linger, the disease should be contained as much as possible, with particular emphasis on the improvement of sanitary conditions and the control of body-fluid contact.

**Bibliography**


