



Ebola Virus Disease (EVD): Important aspects for the food science and technology community

Background

Ebola virus disease (EVD), formerly known as Ebola haemorrhagic fever, is a severe, often fatal illness in humans. It is a zoonosis affecting both humans and non-human primates (NHPs), namely monkeys, gorillas and chimpanzees. The virus is transmitted to humans from wild animals, with the natural reservoir, thought to be species of fruit bats residing in Africa. In the human population, transmission is through human-to-human contact or through contact with infected blood or bodily fluids as well as contaminated items (clothing, bedding and medical equipment). The current EVD case fatality rate is around 50%, but case fatality rates have varied from 25% to 90% in past outbreaks. The first EVD outbreaks occurred practically simultaneously in 1976 in remote villages of the Democratic Republic of Congo (DRC), near the Ebola River, and Sudan, near tropical rain forests. Fatality rates of 88% and 53% respectively were recorded. The sources of transmission of the two species of Ebola virus involved i.e. Zaire ebolavirus in the DRC outbreak and Sudan ebolavirus in the Sudan outbreak, remain unknown. Many years passed before the next outbreak occurred in 1994, this time in Côte d'Ivoire. Subsequent localized outbreaks have occurred in other countries, but the most recent outbreak in West Africa has involved a number of countries in the region, with major urban and rural areas affected. The current outbreak seems to have started in a village near Guéckédou, Guinea, where bat hunting is common, according to Médecins Sans Frontières (Doctors Without Borders). The outbreak has spread to Liberia and Sierra Leone. Imported cases in Nigeria and Senegal were contained demonstrating the effectiveness of rapid response and traditional quarantine measures. An imported case was reported in Mali with five deaths occurring in that country. Ebola virus has also been imported into a number of countries in the developed world. This is the most serious Ebola outbreak so far and as of 19 November 2014, 15,145 confirmed, probable and suspected cases have been reported with 5,420 deaths in eight countries (Huffington Post, 2014c). The World Health Organization (WHO, 2014a) has declared this Ebola outbreak to be a Public Health Emergency of International Concern. The purpose of this Scientific Information Bulletin (SIB) is to review what is currently known about Ebola and to clarify whether it is indeed foodborne. Because events continue to evolve very rapidly with new information becoming available daily, this SIB will continue to be updated periodically hereafter.

Ebola virus disease

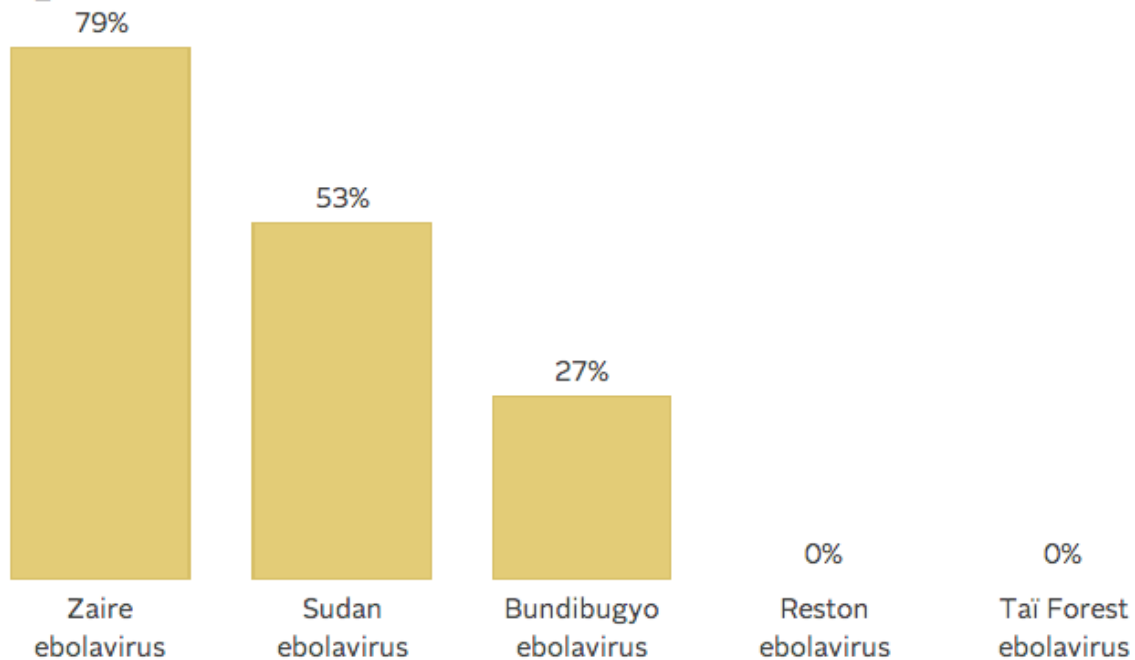
Ebola virus causes a disease, which is severe and often fatal in humans as well as NHPs such as monkeys, gorillas and chimpanzees. Since its identification in 1976, the disease has appeared sporadically in sub-Saharan Africa. The natural reservoir was originally thought to be gorillas because human outbreaks

reservoir for the virus, and that apes and humans become infected from handling and eating raw meat from infected animals (bats or monkeys), fruit that has been covered with bat saliva or feces, or by coming in contact with surfaces covered in infected bat droppings and then touching their eyes, nose or mouths.

Ebola viruses consist of five genetically distinct members of the Filoviridae family: Zaire ebola virus, Sudan ebolavirus, Bundibugyo ebolavirus, Reston ebolavirus and Tai Forest (Côte d'Ivoire) ebolavirus. Reston ebolavirus was isolated from monkeys from the Philippines after having caused disease in NHPs only but was found later in swine suffering from porcine reproductive and respiratory disease syndrome. Zaire, Sudan and Bundibugyo Ebola viruses are responsible for most EVD outbreaks. However, Zaire ebolavirus constitutes the most serious threat to both human and NHPs in Sub-Saharan Africa because of its high case fatality (see Figure 1 below). It has also caused the largest number of outbreaks, including the present one. As of September 2014, the average risk of death among those infected is 50%.

Figure 1

Death rates of the 5 Ebola virus species



Source: CDC
CDC (2014)

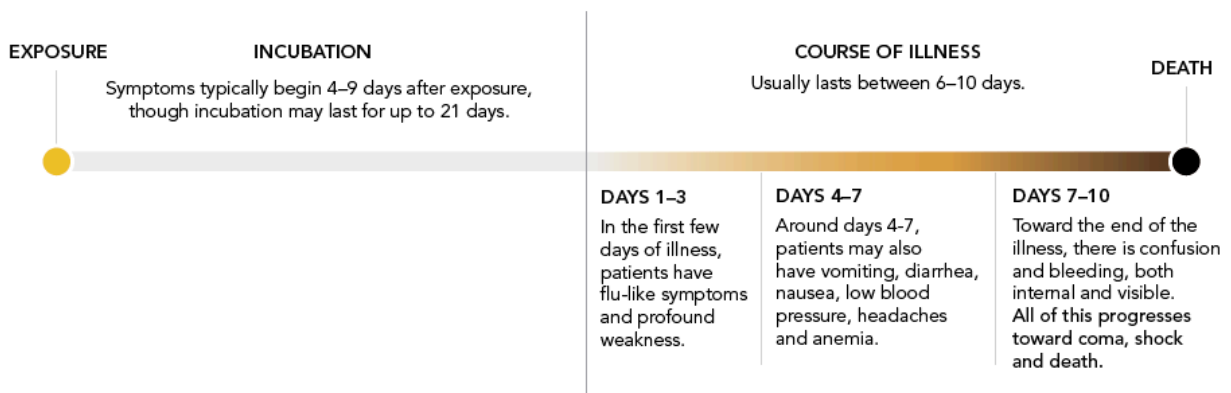


The incubation period, that is, the time interval from infection with the virus to onset of symptoms is 2 to 21 days, with an average of 8-10 days. Importantly, humans are not infectious and therefore cannot transmit the virus, until they develop symptoms. Initial symptoms are the sudden onset of fever, fatigue, muscle pain, headache and sore throat. This is followed by vomiting, diarrhea, abdominal (stomach) pain, rash, symptoms of impaired kidney and liver function, and in some cases, both internal and external bleeding (e.g. oozing from the gums, blood in stools). Laboratory findings include low white blood cell and platelet counts and elevated liver enzymes. In cases that become fatal, death usually occurs 9-10 days after the onset of symptoms. If the patient survives past the second week of infection, there is a significantly increased likelihood of survival. See Figure 2 for an infographic on how Ebola symptoms progress.

Figure 2

How Ebola Symptoms Progress

Infection with the Ebola virus can lead to flu-like symptoms, bleeding (both visible and internal) and, in many cases, death. The current outbreak has a mortality rate of around 60 percent.



Source: Dr. Nahid Bhadelia M.D., M.A., Associate Hospital Epidemiologist, Boston Medical Center
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THE HUFFINGTON POST
 Huffington Post (2014a)

Ebola virus spreads from person-to-person through direct contact with tissue, organs, blood or bodily fluids (including vomit, urine, sweat, saliva, semen and breast milk) from an infected person and through surfaces and materials contaminated with these fluids, including clothing, bedding, medical equipment, used needles and syringes. The virus enters the body through broken skin or mucous membranes (such as eyes, nose or mouth) and is not airborne; however, a cough from a sick person could infect someone who has been sprayed with infected saliva. The virus is also present on a patient's skin after symptoms develop.

Controlling the Ebola outbreak

WHO has stated that community engagement is key to successfully controlling outbreaks and relies on applying a suite of interventions, namely case management, surveillance and contact tracing, good

laboratory services, safe burials and social mobilization. Early supportive care with rehydration and treatment of symptoms improves rates of survival. There is as yet no licensed treatment proven to neutralize the virus but a range of blood, immunological and drug therapies are under development. There are currently no licensed Ebola vaccines but 2 potential candidates are undergoing evaluation. WHO projects that hundreds of thousands of doses of vaccine will be available in the first half of 2015 with millions more by the end of 2015 (WHO, 2014a). Médecins Sans Frontières has announced that three of its treatment centres in West Africa would each host separate research projects to try to find a cure for the Ebola virus. The first trials are due to start in December and the first results could be available in February 2015 (BBC News 2014a).

Is Ebola virus foodborne?

Antibodies to Ebola virus are found in some hunted game animals in Africa, including forest antelopes and rodents. Pigs, guinea pigs, horses and goats have been infected experimentally and either had no symptoms or mild ones. Ebola virus has not been found in any African felines, such as lions, so cats may be immune. Studies of hammer-headed bats in the Democratic Republic of Congo have found that 10 percent of the bats carry antibodies to the virus. Similar studies of fruit bats in Ghana have found a prevalence of 36% with Ebola virus antibodies (Hayman *et al.*, 2012). Of 24 plant species and 19 vertebrate species experimentally inoculated with Ebola virus, only bats became infected. Furthermore, the bats displayed no clinical signs and this suggests that bats are a reservoir species of the virus (Swanepoel *et al.*, 1996). Non-human primates are particularly susceptible to EVD. While the case fatality rate in NHPs is unknown, some ecological data suggest that EVD has contributed to declines of up to 98% of local great ape populations in Gabon and the Republic of Congo. Since NHP groups are geographically separated, the source of the infection is likely to be contact with the reservoir species. Bats are notoriously adept at hosting parasites and pathogens and spreading diseases to other animals. Such viruses like SARS, Marburg and Ebola can be passed to NHPs and ultimately to humans (Muyembe-Tamfum *et al.*, 2012).

As a consequence, WHO (2014a) recommends that:

“Reducing the risk of wildlife-to-human transmission from contact with infected fruit bats or monkeys/apes and the consumption of their raw meat. Animals should be handled with gloves and other appropriate protective clothing. Animal products (blood and meat) should be thoroughly cooked before consumption.”

The US Centers for Disease Control and Prevention (CDC) has flatly stated that Ebola is not foodborne. This viewpoint results most likely because neither bats nor NHPs are eaten or handled in the USA food supply chain. In fact, importing bush meat is not permitted and is subject to a fine of US\$250,000 (CDC, 2014). However, from an international perspective as pointed out by WHO, food handlers and consumers of raw meat from bats or monkeys/apes are at risk of EVD and therefore, Ebola is a foodborne disease in those countries with bush meat traditions.

Bush meat is traditionally eaten in many parts of Sub-Saharan Africa. In some countries, bush meat is an important source of protein where other sources of animal protein are scarce or too expensive. If the

Ebola epidemic continues, farmers may abandon their fields and food markets may be disrupted, which may increase demand for bush meat as a necessary alternative food source. Therefore, WHO (2014a) has provided food safety advice concerning Ebola and has emphasized that if food products are properly prepared and cooked, humans cannot become infected by consuming them as the Ebola virus is inactivated through cooking. More specifically, the Ebola virus is inactivated by heating for 60 minutes at 60 °C or boiling for 5 minutes (HPSC, 2014). WHO (2014a) also emphasizes that basic hygiene measures can prevent infection in people in direct contact with infected animals or with raw meat and by-products. Such measures include regular hand washing, handling potentially infected meat with gloves, and changing of clothes, boots and other protective clothing before and after touching these animals and their products. In addition, sick, diseased or dead animals should never be consumed.

Messages for the food science and technology community

For most of the world, the chances of contracting EVD through food are negligible. Basic food hygiene messages that have been promoted for many years should continue to be invoked as these have a history of successfully preventing the transmission of biological hazards in general and this would certainly be applicable to the Ebola virus as well. These messages are best embodied in the WHO Five keys to safer food (WHO, 2014b), namely:

1. Keep clean
2. Separate raw and cooked
3. Cook thoroughly
4. Keep food at safe temperatures
5. Use safe water and raw materials

In particular, hand-washing by food handlers is important when food will be consumed with no further processing to destroy any possible contamination.

Some other important facts on the Ebola virus that may be of use to the food industry:

- It can survive in liquid or dried material for a number of days;
- It is an envelope virus – one with a lipid and protein membrane – which makes it vulnerable to attack by chemical disinfectants and is inactivated by soap, household bleach, chlorine dioxide, hydrogen peroxide and most other disinfectants
- It is not inactivated by freezing or refrigeration (HPSC, 2014).

Persons working in the food industry who have been exposed to Ebola virus, should be restricted from going to work for the 21 day maximum incubation period to prevent possible transmission of the EVD to other co-workers.

Impact of the outbreak on food security

The current Ebola outbreak has become complex because of its size and scope. Disruption of economic activity, including farming, is a potential threat to the entire food supply, especially for urban consumers. In addition, individuals, families and even communities may be subject to a 21 day quarantine if they were exposed to a symptomatic EVD patient. The inadequate provision of food during this period has already resulted in violation of the cordon sanitaire (Huffington Post, 2014b). The outbreak in Liberia has devastated the economic growth of that country, from a projected 11% to less

than 4% growth for 2014. One in two workers are now jobless in that country as they have either lost their jobs or have been told to stay at home to minimise the spread of the disease, whilst markets have had to shut. More than 90% of people surveyed in Liberia by the World Bank are concerned about not having enough food to eat and more than 70% are worried that they won't have enough money to buy food (BBC News, 2014b).

The World Food Programme (WFP) has the primary objective of preventing the Ebola health crisis from becoming a food and nutrition crisis. In the three most affected countries i.e. Liberia, Sierra Leone and Guinea, the food supply is threatened at many levels, from primary production, processing, distribution and wholesale and retail levels. Farmers are leaving behind their crops and livestock as they seek areas they perceive as safer from exposure to the virus. Travel restrictions and displacements have already affected food prices. The bans on eating traditional protein sources, such as bush meat, may also have implications for the food security and nutrition of people in certain communities. In addition, many households have already lost one or more of family members who were main income providers.

As part of the unified response under the UN Mission for Ebola Emergency Response (UNMEER), the World Food Programme (WFP) has already made food assistance available to about 1.3 million people and is involved in a range of humanitarian efforts in the Guinea, Sierra Leone and Liberia. WFP has provided food assistance to patients in Ebola treatment centers, survivors of Ebola who are discharged from treatment centers and communities with widespread and intense transmission – including the families of people infected with Ebola who are in treatment, deceased, or recovering. This assistance helps to stabilize affected communities by enabling them to limit unnecessary movement.

Besides food, WFP through the Logistics Cluster is also providing crucial transport and logistics support, particularly to medical partners, building Ebola treatment centers and storage hubs for the entire humanitarian community, in both capital cities and remote areas. WFP also manages the UN Humanitarian Response Depots (UNHRD), which store emergency supplies that can be transported within 48 hours from its depots in Ghana and Dubai. In addition, it manages the UN Humanitarian Air Service (UNHAS), which transports humanitarian workers and light cargo to emergencies around the world. In collaboration with WHO and UNICEF, WFP has also provided technical input for the interim guidelines, Nutritional Care in Adults and Children Infected with Ebola Virus Disease in Treatment Centres (WFP, 2014).

References

BBC News (2014a). Ebola: experimental drugs and vaccines. <http://www.bbc.com/news/health-28663217>

BBC News(2014b). Ebola crisis in Liberia: one in two workers now jobless.
<http://www.bbc.com/news/world-africa-30119043>

CDC (Centers for Disease Control and Prevention, USA) (2014). <http://www.cdc.gov/vhf/ebola/>

Hayman, D.T.S., Yu, M., Crameri, G, Wang, L-F, Suu-Ire, R, Wood, J.L.N., *et al.* (2012). Ebola virus antibodies in fruit bats, Ghana, West Africa [letter]. *Emerg Infect Dis* [serial on the Internet]. 2012 Jul [27 October 2014]. <http://dx.doi.org/10.3201/eid1807.111654>

HPSC (Health Protection Surveillance Centre, Ireland) (2014). Advice for healthcare workers, including humanitarian aid workers, returning to or coming to Ireland following travel from an area affected by the Ebola Virus Disease (EVD) outbreak. <http://www.hpsc.ie/A-Z/Vectorborne/ViralHaemorrhagicFever/Ebola/>

Huffington Post (2014a). What actually happens when a person is infected with the Ebola virus. http://www.huffingtonpost.com/2014/08/02/ebola-symptoms-infection-virus_n_5639456.html

Huffington Post (2014b). Thousands break Ebola quarantine to find food. http://www.huffingtonpost.com/2014/11/04/ebola-quarantine-food_n_6099608.html?utm_hp_ref=world

Huffington Post (2014c). Ebola spreading intensely in Sierra Leone as death toll rises: WHO. http://www.huffingtonpost.com/2014/11/19/ebola-sierra-leone_n_6186566.html

Muyembe-Tamfum, J.J., Mulangu, S., Masumu, J., Kayembe, J.M., Kemp, A. & Paweska, J.T. (2012). Ebola virus outbreaks in Africa: Past and present, *Onderstepoort Journal of Veterinary Research* 79(2), Art. #451, 8 pages. <http://dx.doi.org/10.4102/ojvr.v79i2.451>.

Swanepoel, R., Leman P.A., Burt, F.J., Zachariades, N.A., Braack, L.E., Ksiazek, T.G., Rollin, P.E., Zaki, S.R. and Peters, C.J. (1996). Experimental inoculation of plants and animals with Ebola virus. *Emerg Infect Dis* 2 (4): 321–325. doi:10.3201/eid0204.960407. ISSN 1080-6040. PMC 2639914. PMID 8969248.

WFP (World Food Programme) (2014). WFP's response to the Ebola emergency. <http://www.wfp.org/emergencies/ebola>

WHO (World Health Organization) (2014a). Ebola virus disease. Fact Sheet Number 103, September 2014. <http://www.who.int/mediacentre/factsheets/fs103/en/>; <http://www.who.int/csr/disease/ebola/en/>

WHO (2014b). WHO Five keys to safer food. http://www.who.int/foodsafety/areas_work/food-hygiene/5keys/en/

Further Reading

European Commission Public Health (All EU languages) http://ec.europa.eu/health/ebola/index_en.htm

Mayo Clinic (English) <http://www.mayoclinic.org/diseases-conditions/ebola-virus/basics/definition/con-20031241>

Wikipedia (over 100 languages) http://en.wikipedia.org/wiki/Ebola_virus_disease

European Food Safety Authority <http://www.efsa.europa.eu/en/efsajournal/pub/3884.htm>

WHO: Nutritional care of children and adults with Ebola virus disease in treatment centres.
http://who.int/nutrition/publications/guidelines/nutritionalcare_with_ebolavirus/en/

This SIB was prepared by Academy Fellows Lucia Anelich and Gerald G. Moy on behalf of, and approved by, the IUFOST Scientific Council. Lucia Anelich has a PhD in Microbiology and has over 35 years of experience in, academia and the food industry. She started her own consulting business in food safety in 2011 and consults for the Food and Agriculture Organization of the United Nations, the World Health Organization, the Codex Alimentarius Commission (CAC) and the United Nations Industrial Development Organization. She is extraordinary Associate Professor at Stellenbosch University in South Africa, a member of the International Commission on the Microbiological Specification for Foods, acts as food safety expert for the African Union and is Chair Elect of the Scientific Council of IUFOST. Gerald G. Moy, PhD, worked at the World Health Organization from 1987 to 2008, where he served as Regional Advisor for Food Safety for the WHO Western Pacific Regional Office and then as the GEMS/Food Manager in the Department of Food Safety and Zoonoses at WHO Headquarters in Geneva. He currently serves on the International Advisory Committee of the China National Center for Food Safety Risk Assessment, the Technical Advisory Group of the World Food Program Technical Advisory Group and the WHO International Virtual Advisory Group on Mass Gatherings and consults on a range of food safety topics. He is the co-editor of the Food Safety Encyclopedia (Elsevier, 2014) and Total Diet Studies (Springer, 2013).

The International Union of Food Science and Technology (IUFOST) is the global scientific organisation representing more than 300,000 food scientists and technologists from over 75 countries. IUFOST is a full scientific member of ICSU (International Council for Science) and it represents food science and technology to international organizations such as WHO, FAO, UNDP and others.

IUFOST organises world food congresses, among many other activities, to stimulate the ongoing exchange of knowledge and to develop strategies in those scientific disciplines and technologies relating to the expansion, improvement, distribution and conservation of the world's food supply.

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