

## REVIEW ARTICLE

# EBOLA OUTBREAK IN WEST AFRICA

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Received 21<sup>st</sup> November 2015.

Revised 30<sup>th</sup> November 2015.

Published 4<sup>th</sup> December 2015.

### Summary

Viral hemorrhagic fevers (VHFs) represent a collection of illnesses caused by several distinct viral families. While some types of hemorrhagic fever viruses can cause relatively mild illnesses, many of these viruses cause life-threatening diseases. In general, the term „viral hemorrhagic fever“ describes a severe multisystem syndrome. Typical for this syndrome is a systemic damage of vascular system often accompanied by hemorrhages.

Ebola is a type of VHF, along with Marburg, Lassa, dengue, Rift Valley, and yellow fever. VHFs are RNA viruses whose survival is dependent on animal or insect hosts. Ebola hemorrhagic fever initially makes the leap from an animal reservoir to a human, and can then be passed from human to human through direct contact.

In the autumn and winter of 2014 every day professional and popular press published new information about Ebola outbreak in West Africa. It was not just data related to the number of patients, new recommendations and protocols, information about testing of potential vaccines, but also theoretical works that tried to analyze the situation and data.

*Key words: textviral hemorrhagic fevers; Lassa virus; Junin virus; Machupo virus; Omsk hemorrhagic fever; Kyasanur forest fever; yellow fever; dengue; Ebola; Marburg; Rift Valley fever virus; hantaviruses*

## INTRODUCTION

More than 24,000 cases of Ebola virus infection had been reported in West African countries and over

10,000 people died [1]. Tom Frieden, CDC director wrote for Huffington Post during August last year following words: „It’s (Ebola) like fighting a forest fire. Leave behind one burning ember and the epidemic could re-ignite. That ember could be one case undetected, one contact not traced or health care worker not effectively protected, or burial ceremony conducted unsafely.“

VHFs may be caused by viruses from five distinct families of RNA viruses: *Arenaviridae*, *Filoviridae*, *Bunyaviridae*, *Flaviviridae*, and *Rhabdoviridae*.

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The family *Filoviridae* includes two genera - *Ebolavirus* and *Marburgvirus* [2]. There are five identified Ebola virus species, four of which are known to cause disease in humans: *Ebolavirus* (*Zaire ebolavirus*); *Sudan virus* (*Sudan ebolavirus*); *Tai Forest virus* (*Tai Forest ebolavirus*, formerly *Côte d'Ivoire ebolavirus*); and *Bundibugyo virus* (*Bundibugyo ebolavirus*). The fifth, *Reston virus* (*Reston ebolavirus*), has caused disease in nonhuman primates, but not in humans.

All that viruses are named for the regions in which they were discovered.

There is no proven treatment or vaccine for the virus, which attacks the body's immune system, hijacks cells, and weakens blood vessels, leading to shock and multiorgan failure.

From molecular genetic analyses we know that the sequence of the Ebola virus strain circulating in this outbreak in West Africa is similar by its sequences to the Zaire strain (ZEBOV). The ZEBOV Zaire strain was responsible for the first epidemic in Zaire (today Democratic Republic of the Congo) in 1976, when (431 of 602 patients died).

The tubular virion of ZEBOV is about 90 nanometers in diameter and up to 1400 nm long, and consists of a viral envelope, a matrix, and a nucleocapsid, with glycoprotein spikes protruding from its surface.

The virus begins its attack by attaching to host receptors through its glycoprotein. The lipid bilayer buds off from the host cells. Structural proteins linking the viral envelope with the core make up the matrix, important in virus assembly. The nucleocapsid is a series of viral proteins attached to the viral RNA. The virus replicates not by division but by using a combination of host and virally encoded enzymes to produce multiple copies of itself, which self-assemble in the host cell.

Mutations in the sequence of the Ebola virus strain (circulating in West Africa) sequence obviously resulted in decreased numbers of hemorrhagic cases, thus decreasing mortality rate compared to Zaire strain (mortality rate up to 90%).

Similar symptoms to some other diseases with massive occurrence of malaria, typhus fever and cholera, together with a fact, that the outbreak occurred in area where previously not reported

Ebola – all this resulted in the delay of correct diagnosis and late detection of this epidemic [3, 4].

### **Distribution and reservoirs of VHF's**

Causative agents of VHF's are geographically distributed at all settled continents. Natural reservoirs, which were identified only recently, are rodents, fruit bats, ungulate African animals and primates. Humans represent a dead end of the natural transmission chain [5].

### **Transmission of Ebola virus**

Transmissions in the beginning of epidemic occur by a contact with an infected animal due to scratching or bite, or by consuming an infected meal, especially fruit. Ebola virus specifically is transmitted frequently by infected fruit-bats. These animals frequently only bite into the fruit and contaminate it by saliva containing virus. Infected fruit is then eaten by local natives. Fruit bats are also regarded as favorite delicacy as fresh-caught and dried. About 100,000 fruit bats are sold at markets as food in Ghana in a year [6]. Human to human transmission then continues by a contact with body fluids in consequence. The Ebola virus was detected in blood, breast milk, saliva, vomitus, urine and in genital secretions.

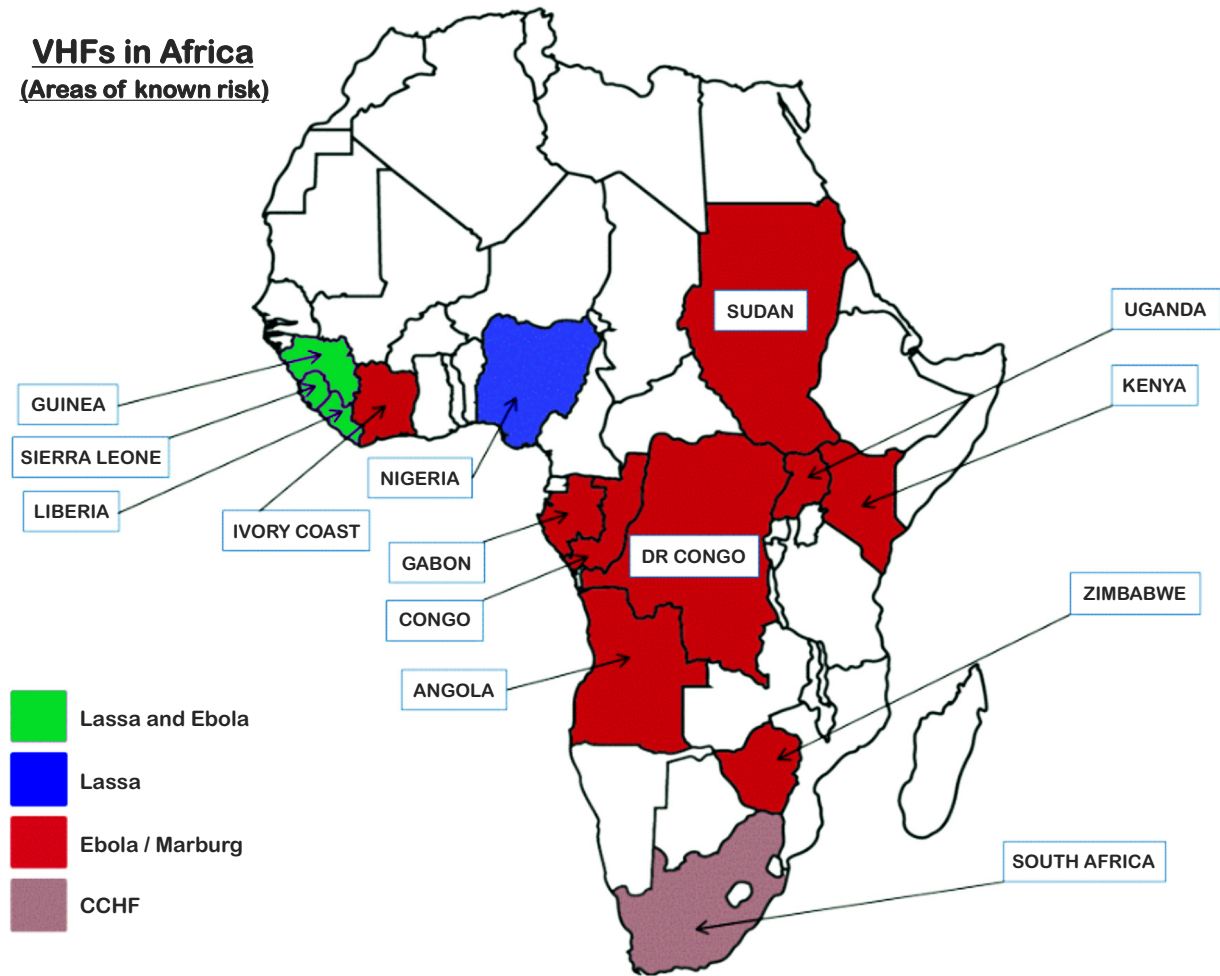
At current state of knowledge it is not possible to anticipate individual cases of infection and predict the development of epidemics [7, 13].

### **Potential initiating factors of the West Africa Ebola outbreak**

One of the opinions indicates that the current outbreak could have been supported or even brought about by changing ecological factors. Countries like Guinea, Liberia or Sierra Leone destroy thousands of hectares of tropical forest for decades due to the mining activities. This changes country climate and draws locals closer to wildlife in order to obtain food by hunting. Time intervals of drought and rainy seasons vary as well as their characters. Such modified climate conditions then support spreading of Ebola virus [8].

According to one of the newer analyses based on ecologic and demographic factors, theoretically fifteen African countries, where virus was mostly never detected, are currently threatened by Ebola virus (Nigeria, Cameroon, Central African Republic, Ghana, Liberia, Sierra Leone, Angola, Tanzania,

**VHFs in Africa**  
(Areas of known risk)



**Figure 1.** Areas of known risk for VHTs in Africa (<https://www.gov.uk/guidance/viral-haemorrhagic-fevers-origins-reservoirs-transmission-and-guidelines>)

Togo, Ethiopia, Mozambique, Burundi, Madagascar, Malawi, Equatorial Guinea [7]).

Population behavior in areas of epidemic spreading also has a significant influence. As one could see at the example of presumptive current epidemic outset, big problems in the infection spreading are generated by local habits, e.g. ritual funerals and other, where a close contact with body fluids of patients and dead occurs [9].

Only targeted and detailed educational training with preventive repressive measures implemented gradually could efficiently help in such cases. Since there is neither a specific drug treatment nor a vaccine available (in spite of currently running clinical trials), such measures are even more important.

**Index case of the Ebola outbreak in West Africa**

On December 26, 2013, two years old boy became sick in Meliandou village in Guinea. He suffered from fever, vomitus, had black stool and died two days later. Fourteen of his relatives and other people preparing his funeral consequently died. At the same time organization called „Doctors without Borders” was fighting with cholera infection in this area. Specimens were sent to Institute of Pasteur in March 2014 by representatives of this organization. Results confirmed suspected diagnosis of first known Ebola virus occurrence in West Africa [1].

**Ebola virus on the way – uncontrolled epidemic**

In Sierra Leone the initial case was successfully managed. The patient was pregnant female with

aborts, correctly isolated in governmental hospital in Kailahunu (24. 5. 2014). Unfortunately, the outbreak became uncontrolled with a death of a highly respected healer in the border zone. Hundreds of people from Sierra Leone and neighboring countries took part in a ritual funeral associated with dead body wash-up, touching and embracing a body and farewell kisses. When the now infected funeral guests returned to their homes the virus spread was initiated to distant areas. About 365 subsequent Ebola deaths are closely associated with this funeral. West African statistics attribute a total of 60% share in infection spreading to the ritual funerals [1].

### The medical care system – new experiences

Fundamental in pathogenesis of Ebola virus infection is a multi - organ system failure. It is therefore necessary to guarantee a high quality medical care due to the absence of both specific antiviral therapy and vaccine. Such medical care is clearly very difficult to provide in poor African countries. Just to compare – seventy medical professionals including laboratory staff cared for one patient with Ebola infection in Emory University Hospital in Atlanta, Georgia, USA. Three nurses took 8 hour shifts in the isolation unit (initially, 12hour shifts were considered, but it was found unrealistic and shifts were shortened on the direct request of the staff). First experience in the successful management of two patients at Emory show a significant importance of a detailed symptomatic therapy with an evaluation of previous health status (immune system, quality of nutrition). The symptomatic treatment includes rehydration with glucose solution and electrolytes (orally, *p.o.*), anal-getsics, antipyretics, antiemetics, drugs for diarrhea, sedatives and major tranquilizers, as well as continual blood pressure and oxygen saturation check [10].

The Kaiser Oakland Hospital, the UC San Francisco, the Emory Atlanta, the Rush Chicago, the John Hopkins Baltimore, the Bellevue New York City and 29 other hospital centers across the USA are since December 2014 equipped and ready to take care of patients with a diagnosis of VHF Ebola. Such hospitals became so called Ebola Treatment Centers based on the demographic data analysis. It is known that 80% of travelers from west Africa live in a circle of 160 km of selected hospitals, or in areas surrounding five US international airports (the JFK in New York, the New Jersey Newark Liberty, The Washington Dulles, the Chicago O'Hara and The Hartsfield-Jackson in Atlanta), which are the only airports for

controlled landing of flights coming from African areas with outbreak. An activated hospital staff and laboratory compartment are currently trained to diagnose and admit patients in these selected health facilities several hours after landing [1].

Outside the USA, a total of 2,450 US military virologists and microbiologists serve in West Africa in seven large hospital bases. Establishment of such mobile diagnostic labs significantly helped to reduce time between obtaining a specimen to its analysis. In the very beginning of the outbreak it took weeks to obtain the results, due to the distance to the specialized laboratories and their small numbers. Currently results are available in hours, calculated from the time of collecting, which could dramatically improve the chances to save lives.

Laboratory staff speaks about enormous stress, to which they are daily exposed. Each tube means not only number and specimen but is associated with specific human destiny as in case of blood specimen of nine years old Guinean boy. His specimen contained still not observed level of viral load, outside of the usual range 1-10. In this case there was no doubt about further fatal development of the diseases. Sad stories are mercifully replaced by more optimistic ones. Health workers together with natives developed ritual for cured patients, which gives a psychological support to both sides. Every cured patient passes through a nurse /attendant/ lane. They embrace themselves and hand over minor gifts. Every cured patient receives „Ebola Cure Certificate“ and brand new clothing and linen [12].

Medical staff continue to learn and train additional necessary safety measures, such as safe handling of medical tools, mutual check of protective suit in a sequence of control steps, disinfection of all material, but they also try make practical life easier by designation of renowned names to laboratory devices like Rambo (specimen analyzer) or Chuck Norris. Such instruments analyze collected material for presence or absence of nucleic acid of Ebola virus and determine viral load parameters in analyzed specimen. A green straight line displayed on the PC monitor means negativity of the specimen. An ascending line indicates positivity and the incline correlates with viral load. All staff in Africa or anywhere in the USA is assigned to these laboratories on the voluntary basis. They know that it is very important to accept any criticism in a positive way and that a mutual check and reminder should be accepted positively and could prevent fatal mistakes [5, 12].

## CONCLUSION

The Ebola virus has become an unwelcome reminder that, for all its advances, modern medicine has yet to win the war against infectious disease. The worst Ebola outbreak in history has thus far impacted nine countries, including the United States, infected more than 24,000 people, and claimed the lives of more than 10,000. It has also shed light on the weakness of health systems and the lack of investment in research and development for diseases primarily impacting the poor, as well as underscored the need for forward thinking investments in research and preparedness.

## ACKNOWLEDGEMENT

This work was supported by the Project of Ministry of Health (Czech Republic) - 15-31847A.

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