

“CAN EBOLA VIRUS DISEASE INFECT DOMESTIC AND FARM ANIMALS AND A THREAT FOR HUMAN BEING WHO HAS DIRECT CONTACT AND CONSUME THEIR FOOD PRODUCTS?” A REVIEW PAPER

Alemayehu Worku

Arba Minch University, College of Agricultural Sciences, Department of Animal and Range Sciences

ABSTRACT: *Ebola virus disease (EVD) also known as Ebola hemorrhagic fever is a severe contagious disease affecting humans, non-human primates and some domestic species (e.g. pigs). While fruit bats are considered as a natural reservoir, the involvement of other species in the EBOV transmission cycle is unclear, especially for domesticated animals. However Dogs and pigs are so far the only domestic animals identified as species that can be infected with EBOV. In 2009 Reston-EBOV was the first EBOV reported to infect swine with indicated transmission to humans; and a survey in Gabon found over 30% sero prevalence for EBOV in dogs during the Ebola outbreak in 2001-2002. While infections in dogs appear to be asymptomatic, pigs experimentally infected with EBOV can develop clinical disease, depending on the virus species and possibly the age of the infected animals. In the experimental settings, pigs can transmit Zaire-Ebola virus to native pigs and macaques monkeys; however, their role during Ebola outbreaks in Africa needs to be clarified. In Africa, fruit bats are considered natural hosts and reservoirs of the Ebola virus although Ebola outbreaks have been observed in chimpanzees, gorillas, macaque monkeys and in some pigs in the Philippines and China. These latter animals, like human beings, have been considered as “accidental hosts” and not reservoirs of the Ebola virus. A fact sheet recently released by the World Health Organization (WHO) has proved helpful in this regard, revealing that the Ebola virus is transmitted to people from animals and subsequently spreads through the human population through person to person contacts. The risk of infection among humans from animals may be reduced by avoiding contact with fruit bats or monkeys etc. avoiding consumption of their raw meat and ensuring that all animal products are thoroughly cooked before consumption. Animal handlers are advised to wear gloves and other protective clothing. Significant issues about disease development remain to be resolved for EBOV. Evaluation of current human vaccine candidates or development of veterinary vaccines de novo for EBOV might need to be considered, especially if pigs or dogs are implicated in the transmission of an African species of EBOV to humans.*

KEYWORDS: Ebola, Virus, Disease, Farm Animals, Food Products, EVD, EBOV

INTRODUCTION

Background

Ebola virus disease (EVD) is also known as Ebola hemorrhagic fever was first discovered in 1976 near the Ebola River in what is now the Democratic Republic of the Congo that affected 318 people and resulted in 280 deaths. Since then, outbreaks of Ebola among humans have appeared sporadically in Africa. The virus and its five subtypes belong to a family of viruses

called Filoviridae; only four of the five subtypes have caused disease in humans (Jane H., 2012).

EVD is a severe contagious disease affecting humans, non-human primates and some domestic species (e.g. pigs). It can be transmitted to humans through direct contact with blood, tissues, body fluids and secretions from an infected animal or human, and from the handling of wild animals hunted for food (WHO, 2014). The causative agent is classified in the genus Ebolavirus of the *Filoviridae* family (Radford, D. *et al*, 2014).

The five known species in the genus Ebolavirus (EBOV) are: *Zaire ebolavirus* (ZEBOV); *Sudan ebolavirus* (SEBOV); *Bundibugyo ebolavirus* (BEBOV); *Reston ebolavirus* (REBOV) and *Tai Forest ebolavirus* (TEBOV). Their genomes can differ by 30-40%. Base on available evidence, it is presumed that REBOV has a low pathogenicity or is non-pathogenic in humans whilst the ZEBOV and SEBOV strains are known for their virulence and high case fatality rate (53 -90%) in humans (Radford, D. *et al*, 2014).

Scientists believe Ebola spreads through zoonotic transmission- that is, coming from an animal. The first patient of an Ebola outbreak is thought to be infected through contact with an infected animal. From there, the virus can spread to other humans through direct contact with blood or body fluids. Outbreaks often occur in healthcare settings (known as nosocomial transmission), as patients seek treatment in facilities where appropriate infection-control may not be practiced. The symptoms of Ebola are somewhat nonspecific at first. Within 2-21 days of exposure, patients usually experience fever, headache, joint and muscle aches, sore throat, and weakness, later followed by diarrhea, vomiting and stomach pain. Some patients also experience rash, red eyes, hiccups and bleeding. From the onset of symptoms, Ebola can kill a patient within a matter of days (Jane H., 2012).

In Africa, fruit bats are considered natural hosts and reservoirs of the Ebola virus although Ebola outbreaks have been observed in chimpanzees, gorillas, macaque monkeys and in some pigs in the Philippines and China. These latter animals, like human beings, have been considered as “accidental hosts” and not reservoirs of the Ebola virus. Both the World Health Organization and recent reports have suggested that the 2014 outbreak of Ebola can be traced to fruit bats in the West Africa region. Guinea, where bat soup is a local delicacy, has reportedly banned the sale and consumption of bat meat since the start of the outbreak (Naina, B. 2014). A fact sheet recently released by the World Health Organization (WHO) has proved helpful in this regard, revealing that the Ebola virus is transmitted to people from animals and subsequently spreads through the human population through person to person contacts (WHO, 2014).

Ebola is introduced into the human population through close contact with the blood, secretions, organs or other bodily fluids of infected animals. In Africa, infection has been documented through the handling of infected chimpanzees, gorillas, fruit bats, monkeys, forest antelope and porcupines found ill or dead or in the rainforest. Ebola then spreads in the community through human-to-human transmission, with infection resulting from direct contact (through broken skin or mucous membranes) with the blood, secretions, organs or other bodily fluids of infected people, and indirect contact with environments contaminated with such fluids. Burial ceremonies in which mourners have direct contact with the body of the deceased person can also play a role in the transmission of Ebola. Men who have recovered from the disease can still transmit the virus through their semen for up to 7 weeks after recovery from illness (WHO, 2014).

Given its high case fatality rates, prevention is critical. Efforts to control Ebola virus infection among domestic animals may include routine cleaning and disinfection with sodium hypochlorite or other detergents in monkey and pig farms, and quarantining the premises and restricting animal movement during suspected outbreaks. Essentially, an active animal surveillance system is required as an early warning mechanism as infections among especially pigs and monkeys are known to precede outbreaks in humans.

The risk of infection among humans from animals may be reduced by avoiding contact with fruit bats or monkeys etc. avoiding consumption of their raw meat and ensuring that all animal products are thoroughly cooked before consumption. Animal handlers are advised to wear gloves and other protective clothing.

Objectives

- To investigate whether the Ebola virus disease can infect domestic or farm animals based on the different study conducted so far.

LITERATURE REVIEW

What is Zoonosis Disease?

Zoonotic diseases are infectious diseases that are naturally transmitted from vertebrate animals to humans and vice versa. They are caused by all types of pathogenic agents, including bacteria, parasites, fungi, viruses and prions. Although they have been recognized for many centuries, their impact on public health has increased in the last few decades due to a combination of the success in reducing the spread of human infectious diseases through vaccination and effective therapies and the emergence of novel zoonotic diseases (Wang and Crameri, 2014).

As zoonosis is by definition transmissible between animals and humans, it is not surprising that most are also transmissible between wildlife and domestic animals. Transmission depends upon contact (direct or indirect) between livestock, domestic animals and people and transmission opportunities are subject to various, sometimes opposing drivers. The unprecedentedly large human population and the associated increases in demand for land, food (and use of natural resources is the root cause of increased transmission opportunities (Grace and Johns, 2011).

The World Health Organization (WHO)/Food and Agriculture Organization of the United Nations (FAO)/World Organization for Animal Health (OIE) joint consultation on emerging zoonotic diseases held in Geneva, May 2004, defined an emerging zoonosis as ‘a zoonosis that is newly recognized or newly evolved, or that has occurred previously but shows an increase in incidence or expansion in geographical, host or vector range’ (WHO, 2004). Emerging zoonotic diseases have potentially serious human health and economic impacts and their current upwards trend is likely to continue. The last 30 years have seen a rise in emerging infectious diseases in humans and of these over 70% are zoonotic (Jhones *et al*; 2008, Woolhouse *et al* 2005). Zoonotic infections are not new. They have always featured among the wide range of human diseases and most, e.g. anthrax, tuberculosis, plague, yellow fever and influenza, have come from domestic animals, poultry and livestock. However, with changes in

the environment, human behavior and habitat, increasingly these infections are emerging from wildlife species.

The WHO and most infectious disease experts agree that the source of the next human pandemic is likely to be zoonotic, and wildlife is emerging as the primary source. Many zoonoses from wildlife, including avian influenza and rabies, are well established, while others have only recently emerged or have only recently been linked to wildlife reservoir species. One example of the latter is the Ebola virus, which, after decades of research, was recently linked to cave-dwelling bats in Africa (Leroy. *et al* 2008 and Li. *et al* 2005).

Emerging Disease

While each of us come and go about our daily business, there is a secret hidden war that is occurring all around us. It is a war between humanity, and the various populations of microorganisms all around us. There are approximately 1,407 organisms (fungi, bacteria, parasites, protozoa and viruses) that can infect humans. Roughly 58% of these are considered to be animal diseases, and most of these have an Old World origin as a result of man's development of agriculture and animal domestication. In addition, there are now some 177 pathogens considered to cause newly emerging or reemerging diseases.

The term *emerging disease* defines an infectious disease that has newly appeared in a population, or is rapidly increasing in incidence or geographic range. During the past 30 years some 41 new infectious organisms or strains have jumped from their animal hosts into humans. This is typified by the period of 2012 to 2014, with the appearance of the *Middle East Respiratory Syndrome Coronavirus (MERS-CoV)*, the lethal Bas-Congo rhabdovirus that causes hemorrhagic fever and kills within a few days, the large Sierra Leone-Liberia- Ebola outbreak, the continuing Kasai Oriental Province outbreaks of human Monkeypox, and cases of African Chikungunya virus in Florida with an epidemic currently underway in Puerto Rico.

One significant emerging infection is the Ebola Virus. The Ebola virus is nothing more than a collection of seven different proteins surrounding a strand of nucleic acid which contains the instructions for making copies of those proteins once the virus enters a human cell. As with all viruses known to science, the Ebola virus borders on the definition of what is considered a living organism.

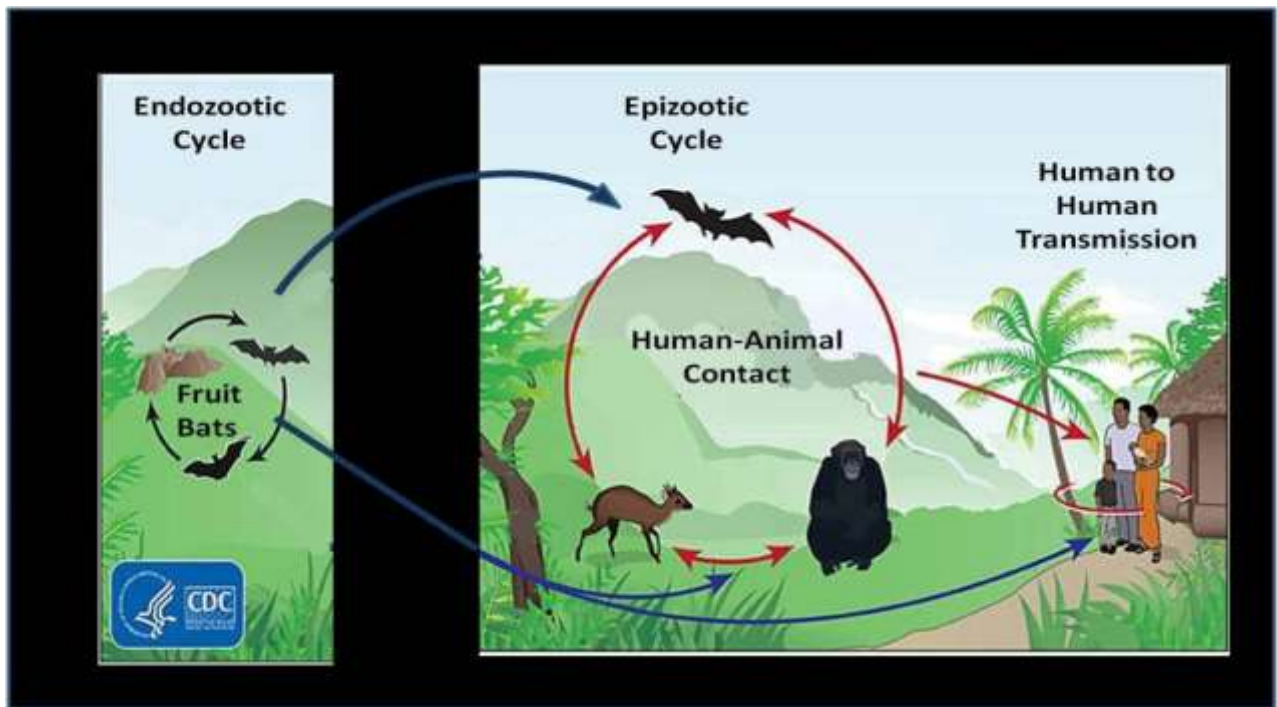
Can Domestic and farm animals shed Ebola and transmit to human?

What animals have been shown to shed Ebola virus?

Field studies and epidemiological surveys in Africa have demonstrated widespread antibody prevalence to Ebola viruses in fruit bats suggesting that fruit bats may be natural hosts for EBOV. When bats and other vertebrate species were experimentally inoculated, only bats became infected and shed virus in feces without showing any clinical signs. Monkeys are not considered as natural hosts because of their high sensitivity to the virus and their high mortality rate when infected. Only mammals (for example, humans, bats, monkeys, and apes) have shown the ability to become infected with and spread Ebola virus.

The role of pigs in EVD epidemiology is unclear. Pigs infected with ZEBOV showed mild clinical signs, and were able to transmit the virus to non-human primates (Weingartl et al 2012).

There is no evidence that domestic animals play an active epidemiological role in the transmission of the disease to humans, although field studies are non-existent.



Can pets become infected with Ebola virus?

A study in 2005 identified an increasing seropositivity to ZEBOV in dogs sampled in regions of Africa that were proximate or distant from known ZEBOV outbreaks – the closer the dog was to the outbreak region, the more likely it was to have antibodies directed against ZEBOV. However, the authors failed to detect either RNA (by RT-PCR) or viral antigen (by viral isolation, although viral isolation failed in the positive control samples as well). The authors concluded that ZEBOV could induce an immune response in dogs, but could not determine if dogs could shed the virus.

Guinea pigs, goats, and horses remain subclinical or develop mild clinical signs after experimental infection, but Ebola virus infection has never been observed in these species in the wild.

The Ebola virus can be found across the animal kingdom, from bats and birds to pigs and porcupines. But there is a difference between having a disease and transmitting it to another animal or another species. That's at the heart of a controversial move by Spanish health authorities, who have obtained a court order to euthanize the dog belonging to a nurse who contracted the Ebola virus in Madrid, saying that available scientific knowledge suggests dogs can transmit the virus to humans. But how much do we know about which animals can catch and transmit the deadly virus? (Naina, B. 2014)

Dr. Tom Frieden, director of the U.S. Centers for Disease Control and Prevention (CDC), said in a news conference on Tuesday that "we know in rural areas of Africa, Ebola can infect mammals. In fact, that's how it spreads, from probably bats to animals living in the forest, people hunting the animals." Ebola has to date been found in many bush animals, including

bush pigs, rodents, porcupines and forest-dwelling antelope. Any infected carcasses could spread the virus to hunters or to anyone who eats bush meat (Naina, B.2014).

Can Dogs get Ebola?

Yes. After the 2002 Ebola outbreak in Gabon, researchers from the US Centers for Disease Control and Prevention (CDC) discovered that many of the animals that came into direct contact with disease, later tested positive for it. It is believed the dogs contracted the virus by scavenging for infected bush meat, but it could also have been transmitted through contact with the bodily fluids of an infected human. However the virus had no harmful effect on the canines as they showed no symptoms and did not become ill or die.

However up to the recent date, there is no documented case of Ebola spreading to people from dogs or dogs to people, and only one study, carried out by the CDC, looks at whether dogs can get Ebola at all. This research into the prevalence of Ebola-virus antibodies in dogs from regions of Gabon affected by the 2001–2002 outbreak showed that “dogs can be infected by Ebola virus” but exhibit no symptoms and the infection eventually clears (Naina, B.2014).

The researchers concluded that “dogs could be a potential source of human Ebola outbreaks and of virus spread during human outbreaks,” but they did not test their hypothesis that human infection could occur through licking, biting or grooming. Instead, the study assumed dogs would transmit the infection in the same way as other animals observed in experiments; those animals excreted viral particles (in saliva, urine, feces) for a short period before the virus was cleared. David Moore, an expert in infectious diseases from the London School of Hygiene and Tropical Medicine, said that since no dogs showed symptoms of the Ebola virus “there is absolutely no evidence to support a role for dogs in transmission.

The study also suggests that differences in behavior and diet of pet dogs may alter risks in Ebola transmission. Whereas most dogs in Western Europe are fed dog food, many of the dogs studied in Gabon scavenged for their food, eating small dead animals that could have exposed them to the virus.

On the other hand dogs are not subclinical carriers of Ebola virus and there also not be any information on how long can a dog be infected with Ebola Virus. In this regard recent study indicates that there is no evidence currently that dogs can carry and shed Ebola virus. No virus has ever been isolated from a dog. Also Since there is no evidence that dogs can become infected with Ebola virus, there is no way to estimate duration of infectivity (which would involve viral replication and shedding). Dog is not seropositive for anti-Ebola antibodies infected and can then transmit the virus. Seroconversion only requires that antigen be presented by antigen-presenting cells to lymphocytes. Infection requires invasion of host cells, replication, and shedding.

Can Birds get Ebola?

There is limited data about the prevalence of Ebola in birds but a 2002 study from Purdue University found that the Ebola virus closely resembles the structure of several bird viruses. This means birds may be able to spread the virus to humans. Head researcher David Sanders said “while bird transmission of Ebola is by no means certain, the resemblance among all these viruses should encourage health officials to be on guard for it.

Can Pigs Get Ebola?

Until 2009 no one knew that pigs could carry Ebola, because they show no symptoms of the disease. Three years after a case in the Philippines showed Ebola transmission between pigs and farmers, Canadian scientists found that apparently healthy pigs could pass on the most deadly strain of Ebola (the Zaire-Ebola virus) to monkeys without direct contact. In pigs, the virus mainly affects the lungs and airways, which means they can spread the virus through the air via small droplets (this does not mean Ebola is suddenly an airborne virus like SARS). However, Gary Kobinger who led the study said “we still don’t know if pigs are playing any role in the natural transmission or ecology of Ebola virus in Africa.” (Naina, B., 2014).

Can Domestic Animals Gets Ebola?

Various studies carried out in the 1990s found that some animals (including guinea pigs, goats and horses) showed no or mild symptoms when infected with Ebola during experiments. The virus has never been observed in these species in the wild, but like pigs and dogs, these animals do not appear to get ill or die from Ebola.

Relatively little research has been carried out into the existence of Ebola in many other animals. It is thought that domestic cats are probably immune to it since the virus has not yet been found in any wild felines in Africa.

Some Facts about Ebola Transmission

Can pets transmit Ebola virus to people or other animals?

There is no evidence that domestic species, including dogs, can or ever have, transmitted Ebola virus to humans or other animals. Some investigators have questioned the role of dogs in transmission where no obvious source was identified in an outbreak; however, these outbreaks occur in regions where exposure documentation is limited, incomplete or inaccurate. Therefore, such hypotheses are speculative at best. On the other hand, rigorous investigation of potential canine infections in field situations is virtually non-existent.

Is Ebola transmitted via aerosol?

There is no evidence that Ebola virus is transmitted by aerosol, water or food. In two separate experimental studies—one with monkeys and the other pigs and monkeys—the authors suggest an airborne possibility of transmission. However, this route of transmission was not confirmed and other means of transmission were not ruled out. (Jaax et al, 1995, Weingartl et al 2012).

What should be done with a pet in the home of an Ebola patient?

CDC recommends that public health officials, in collaboration with a veterinarian, evaluate the pet’s risk of exposure to the virus (close contact or exposure to blood or body fluids of an Ebola patient). Based on this evaluation as well as the specific situation, local and state human and animal health officials will determine how the pet should be handled. Currently, a dog exposed to an infected health worker in Texas, is being quarantined at a decommissioned military base. A veterinarian who is caring for the animal of an Ebola patient or the animal of someone who has been in contact with an Ebola patient should contact their state health department for guidance.

What is the evidence about fomite (including fur) transmission and survival times of the virus?

While there is no evidence that the virus can be transmitted on the fur or saliva of dogs, there is some evidence that fomite-associated transmission might occur (Jaax N et al, 1995). Therefore, the CDC advises that the most prudent course of action is to keep pets away from people who have been exposed to, or are infected with, Ebola virus.

Can Ebola virus survive in the environment?

Ebola viruses are encapsulated viruses and therefore sensitive to desiccations, detergents and disinfectants. They do not survive for long in the environment (hours, rather than days or weeks), and can be inactivated with exposure to many disinfectants. According to the Centers for Disease Control and Prevention (CDC): “The role of the environment in transmission has not been established. Limited laboratory studies under favorable conditions indicate that Ebola virus can remain viable on solid surfaces, with concentrations falling slowly over several days. In the only study to assess contamination of the patient care environment during an outbreak, virus was not detected in any of 33 samples collected from sites that were not visibly bloody...There is no epidemiologic evidence of Ebola virus transmission via either the environment or fomites that could become contaminated during patient care (e.g., bed rails, door knobs, laundry). However, given the apparent low infectious dose, potential of high virus titers in the blood of ill patients, and disease severity, higher levels of precaution are warranted to reduce the potential risk posed by contaminated surfaces in the patient care environment.”

Should we worry?

Scientists have yet to confirm Ebola’s natural host—the animal that naturally holds the infection and is a primary source for the spread of the disease—but transmitting the virus is a different issue. Since “lethal disease has only thus far been seen in humans and primates and a few species of wild animals, it would appear that the main route of transmission is human to human contact,” says John Blackwell, President of the British Veterinary Association, an organization that often issues advice when animal-related diseases could affect the general public(Naina, B., 2014).

He adds that the course of disease in dogs and their role in transmission is not yet known, but “it would be a sensible precaution” to observe strict quarantine measures for animals in contact with a confirmed or suspected case of Ebola. As the Madrid nurse and her husband continue to campaign to save their dog from being put down, it remains to be seen what precautions the Spanish government will take in order to contain the spread of the Ebola virus.

CONCLUSIONS

Based on the review of different scenario so far with regard to infection of domestic and farm animals as well as their role in transmitting the disease as a host animal, the following conclusions are drawn

- In Africa, fruit bats are considered natural hosts and reservoirs of the Ebola virus, while the involvement of other species in the EBOV transmission cycle is still unclear, especially for domesticated animals.

- Ebola outbreaks have been observed in chimpanzees, gorillas, macaque monkeys and in some pigs in the Philippines and China. These latter animals, like human beings, have been considered as “accidental hosts” and not reservoirs of the Ebola virus.
- Dogs and pigs are so far the only domestic animals identified as species that can be infected with EBOV. While infections in dogs appear to be asymptomatic, pigs experimentally infected with EBOV can develop clinical disease, depending on the virus species and possibly the age of the infected animals.
- Guinea pigs, goats, and horses remain subclinical or develop mild clinical signs after experimental infection, but Ebola virus infection has never been observed in these species in the wild.
- In 2009 Reston-EBOV was the first EBOV reported to infect swine with indicated transmission to humans; and a survey in Gabon found over 30% sero prevalence for EBOV in dogs during the Ebola outbreak in 2001-2002.
- In the experimental settings, pigs can transmit Zaire-Ebola virus to naive pigs and macaques monkeys; however, their role during Ebola outbreaks in Africa needs to be clarified.
- A fact sheet recently released by the World Health Organization (WHO) has proved helpful in this regard, revealing that the Ebola virus is transmitted to people from animals and subsequently spreads through the human population through person to person contacts.
- The risk of infection among humans from animals may be reduced by avoiding contact with fruit bats or monkeys etc. avoiding consumption of their raw meat and ensuring that all animal products are thoroughly cooked before consumption. Animal handlers are advised to wear gloves and other protective clothing.
- Significant issues about disease development remain to be resolved for EBOV. Evaluation of current human vaccine candidates or development of veterinary vaccines de novo for EBOV might need to be considered, especially if pigs or dogs are implicated in the transmission of an African species of EBOV to humans.

REFERENCES

- Jane H., 2012. Did Scientists Just Discover a Cure for Ebola? The Disease daily magazine, published on June 22, 2012.
- Naina Bajeka. 2014. Ebola and domestic animals/Can Dogs (And Other Animals) Get Ebola_ TIME.html
- WHO (2014). WHO Statement on the Meeting of the International Health Regulations Emergency Committee regarding the 2014 Ebola outbreak in West Africa.
- Radford, D. and J.Scott Weese 2014. Ebola and domestic animals/01 Veterinary Considerations for Ebola Virus Outbreaks - VeterinaryPartner.com - a VIN company.
- Allela L, Bourry O, Pouillot R, Delicat A, Yaba P, Kumulungui B, Rouquet P, Gonzalez J-P, Leroy EM. Ebola virus antibody prevalence in dogs and human risk. *Emerg. Infect. Dis.* 2005;11(3):385-390.

Jaax N, Jahrling P, Geisbert T, Geisbert J, Steele K, McKee K, et al. Transmission of Ebola virus (Zaire strain) to uninfected control monkeys in a biocontainment laboratory.

Lancet. 1995;346:1669–71.

Weingartl HM, Embury-Hyatt C, Nfon C, Leung A, Smith G, & Kobinger G. Transmission of Ebola virus from pigs to non-human primates. Scientific Reports Nov. 15, 2012.