Ebola Virus Disease in Domestic and Wild Animals: A Review

Hailu Hambese[1]   Tsehaye Hadush[1*]   Alebachew Tilahun[1]   Ayichew Teshale[1]   Abebaw Getachew[2]

1 Wolaita Sodo University, School of Veterinary Medicine, Ethiopia

2 Agarfa Agricultural Technical and Vocational Educational Training College, Ethiopia

Summery

Ebola virus disease (formerly Ebola hemorrhagic fever) is an acute viral syndrome that presents with fever and an ensuing bleeding diathesis that is marked by high mortality in human and nonhuman primates. The disease is caused by genus *Ebola virus*. *Ebola virus* consists five species namely *Zaire ebolavirus*, *Sudan ebolavirus*, *Taï Forest ebolavirus* (formerly *Cote d'Ivoire ebolavirus*), *Reston ebolavirus* and *Bundibugyo ebolavirus*. Among them the *Bundibugyo ebolavirus*, *Zaire ebolavirus*, and *Sudan ebolavirus* have been associated with large outbreaks in Africa. Fruit bats are considered to be the only natural host of the Ebola virus. Nonhuman primates are severely affected by filoviruses. EBOV is thought to enter the human population through exposure to the bodily fluids of an infected fruit bat or mammal, especially non-human primates. In general there is no or little evidence that domestic animals play an active epidemiological role in the transmission of the disease to humans. Dogs appear to be the first animal species shown to be naturally and asymptomatically infected by Ebola virus. The diagnosis of EVD is confirmed by isolating the virus, detecting its RNA or proteins by PCR, or detecting antibodies against the virus by ELISA. To control EBV disease, good food preparation practices, animal testing for Ebola virus, culling of infected animals, with close supervision of burial or incineration of carcasses, may be necessary to reduce the risk of animal-to-human transmission. Disease reporting, routine cleaning and disinfection and restricting or banning the movement of animals from infected farms to other areas can reduce the spread of the disease.

Keywords: Ebola virus disease, Domestic animals, Wild animals, Natural reservoir host

1. Introduction

Ebola virus disease formerly known as Ebola hemorrhagic fever (EHF) is an acute viral syndrome that presents with fever and an ensuing bleeding diathesis that is marked by high mortality in human and nonhuman primates. The natural reservoir of the virus is unknown. As a result, little is understood about how Ebola virus is transmitted or how it replicates in its host. Although the primary source of infection is unknown, the epidemiologic mode of transmission is well defined (Casillas *et al.,* 2003).

Ebola virus disease is one example of emerging infectious diseases which was first discovered in 1976. It is a serious and often fatal illness that has been in the news in recent weeks. Recently, there have been largest Ebola outbreaks of Ebola virus disease in West Africa. The World Health Organization (WHO) declared it an outbreak in March 2014 and on August 8, 2014 a public health emergency of international concern. Based on the number of deaths and total number of cases reported to the WHO as of August 11, 2014, the current outbreak has an overall mortality rate of 55%. According to the report, number of Ebola-linked cases passes 10,000, and more than5, 000 Dead (Semalulu *et al.,* 2014).

Ebola hemorrhagic fever outbreaks occurred in villages where people keep domestic animals, including dogs. Dogs eat small dead animals found near the villages and also internal organs of wild animals hunted and slaughtered by villagers. Although canine infection by Ebola virus has never been documented, studies on dogs in West Africa have shown that dogs develop antibodies when exposed to Ebola, suggesting that they may develop mild infections without becoming sick. However, very little is known about how other domestic animals respond to Ebola virus (Loïs *et al.,* 2005). This short review offers the first evidence that dogs might be asymptomatically infected by Ebola virus. This finding has potential implications for preventing and controlling human outbreaks (Goldsmith and Zaki, 2010).

Preventing the occurrence of such diseases requires higher levels of biosecurity, and thus, appropriate training in medical and veterinary schools and universities, but also general information for all people and precautions to minimize the risk of contracting such zoonotic diseases (Goldsmith and Zaki, 2010).

The objectives of this short review are:-

➤ To assess the general knowledge about Ebola virus disease, regarding the possible host which is susceptible for the virus, the possible means of transmission from animal to human, ways to reduce transmissions and the prevalence in domestic and wild animals.

➤ To discuss with societies, particularly those professionals frequently exposed to animals, to be aware of EVD, and to take precautions to minimize the risk of contracting such zoonotic disease as it's very serious and chance recovery is very low.

2. Ebola Virus Disease

Ebola hemorrhagic fever (EHF) is an acute viral syndrome that presents with fever and an ensuing bleeding diathesis that is marked by high mortality in human and nonhuman primates. Fatality rates are between 50% and 100%. Due to its lethal nature, this filovirus is classified as a biological class 4 pathogen. The natural reservoir of the virus is unknown. As a result, little is understood about how Ebola virus is transmitted or how it replicates in its host. Although the primary source of infection is unknown, the epidemiologic mode of transmission is well defined (Casillas *et al.,* 2003).

2.1. Historical Back Ground of Ebola Virus Disease

In 1976, Ebola (named after the Ebola River in Zaire) first emerged in Sudan and Zaire. The first outbreak of Ebola (Ebola-Sudan) infected over 284 people, with a mortality rate of 53%. A few months later, the second Ebola virus emerged from Yambuku, Zaire, Ebola-Zaire (EBOZ). EBOZ, with the highest mortality rate of any of the Ebola viruses (88%), infected 318 people. The third strain of Ebola, Ebola Reston (EBOR), was first identified in 1989 when infected monkeys were imported into Reston, Virginia, from Mindanao in the Philippines. Fortunately, the few people who were infected with EBOR (seroconverted) never developed Ebola hemorrhagic fever (EHF). In 2008, however, *Reston ebolavirus* was discovered in pigs during an unusually severe outbreak of porcine reproductive and respiratory syndrome (PRRS) in the Philippines. Recently, this virus was also found in pigs with PRRS in China (Spickler and Anna, 2014). The last known strain of Ebola, Ebola Cote d'Ivoire (EBO-CI) was discovered in 1994 when a female ethologist performing a necropsy on a dead chimpanzee from the Tai Forest, Cote d'Ivoire, accidentally infected herself during the necropsy (Waterman, 1999).

April 3, 2014 -WHO is supporting the national authorities in the response to an outbreak of Ebola virus disease (EVD; formerly known as Ebola haemorrhagic fever). The outbreak is now confirmed to be caused by a strain of *ebolavirus* with very close homology (98%) to the *Zaire ebolavirus*. This is the first time the disease has been detected in West Africa. Cases were first reported from forested areas in South-eastern Guinea. The outbreak has rapidly evolved and several districts and Conakry have reported cases and deaths caused by EVD. A small number of suspected cases and deaths have also been reported from neighboring countries with all of them having crossed from Guinea. Confirmed cases have been reported from Guinea and Liberia (WHO, 2014).

This year, Ebola virus returned to the center stage as the Western African countries of Guinea, Liberia, and Sierra Leone are facing an unprecedented and uncontrolled outbreak caused by a new Zaire Ebola virus strain. The number of cases in this outbreak has surpassed that for all previously reported Ebola virus outbreaks combined (Halfmann *et al.,* 2014).

2.2. Etiology

The causative agent is classified in the genus *Ebolavirus* of the Filoviridae family of order Mononegavirales. Filoviruses are filamentous enveloped viruses containing a non-segmented, negative-strand genomic RNA of approximately 19 kilobases. The virus family *Filoviridae* includes 3 genera: *Cuevavirus*, *Marburgvirus*, and *Ebolavirus*. The names of these viruses have undergone several taxonomic changes since they were first discovered, including new changes officially accepted in 2013. Currently, the genus *Ebolavirus* contains five recognized viral species: *Zaire ebolavirus*, *Sudan ebolavirus*, *Taï Forest ebolavirus* (formerly *Cote d'Ivoire ebolavirus*), *Reston ebolavirus* and *Bundibugyo ebolavirus*. The common name for the single virus in each of these species is *Ebola virus* (formerly *Zaire ebolavirus*), *Sudan virus* (formerly *Sudan ebolavirus*), *Tai Forest virus* (formerly *Cote d'Ivoire ebolavirus*), *Reston virus* (formerly *Reston ebolavirus*) and *Bundibugyo virus* (formerly *Bundibugyoebolavirus*). The *Bundibugyo ebolavirus*, *Zaire ebolavirus*, and *Sudan ebolavirus* have been associated with large outbreaks in Africa. The virus causing the 2014 West African outbreak belongs to the Zaire species (Sarah, 2014).

Ebola virus is nonsegmented, negative-sense, single-stranded RNA virus that resemble rhabdoviruses and paramyxoviruses in its genome organization and replication mechanisms (Mike, 2014). The following figure shows Electron microscopically appearance for Ebola virus particle and its characteristic filamentous shape**.**
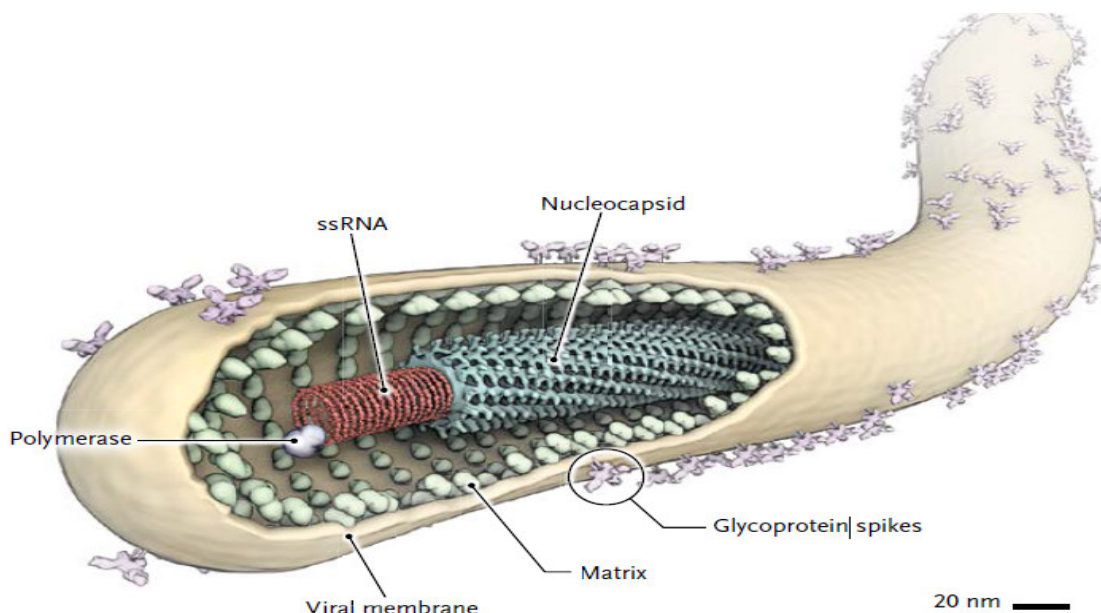
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Figure-1: Ebola virus particles and its characteristic filamentous shape.
Source: (Feldmann, 2014)

2.3. Epidemiology

Ebola virus, was first recognized when two outbreaks occurred in Zaire and in Sudan in 1976. An epidemic caused by the Zaire species caused several hundred cases in 1995 in Kikwit, Democratic Republic of the Congo, and the Sudan virus infected more than 400 people in Gulu, Uganda in 2000 (Mike and Daniel, 2015).

Currently, West Africa is facing the largest outbreak of Ebola virus disease (EVD) in history. The virus causing this outbreak, the Zaire Ebolavirus (EBOV), belongs to the genus Ebolavirus which together with the genus Marburgvirus forms the family of the Filoviridae. EBOV is one of the most virulent pathogens among the viral haemorrhagic fevers, and case fatality rates up to 90% have been reported. Mortality is the result of multi-organ failure and severe bleeding complications (Goeijenbier *et al.,* 2014).

In addition to causing human infections, Ebola virus has also spread to wild nonhuman primates, apparently as a result of their contact with an unidentified reservoir host, possibly bats. This has contributed to a marked reduction in chimpanzee and gorilla populations in Central Africa, and has also triggered some human epidemics due to handling of and/or consumption of sick or dead animals by local villagers as a source of food (Leroy *et al.,* 2004).

Although all previous Ebola outbreaks occurred in Central Africa, an epidemic began in the West African nation of Guinea in late 2013 and was confirmed by the World Health Organization (WHO) in March 2014 (Baize et al., 2014;WHO, 2014). The outbreak subsequently spread to Liberia, Sierra Leone, Nigeria, Senegal, and Mali (Gore *et al.,* 2014). The 2014-2015 Ebola epidemic, caused by the Zaire species of virus, is not only the first to occur in West Africa, but is far larger than all previous outbreaks combined (Mike and Daniel, 2015).

2.3.1. Geographical distribution

The disease typically occurs in outbreaks in tropical regions of Sub-Saharan Africa. Confirmed cases of EVD have been reported in Africa such as Liberia, Sierra Leone, Guinea, Ghana, Nigeria, the Democratic Republic of the Congo, Gabon, Sudan, the Ivory Coast, and Uganda (Nishiura and Chowell, 2014).

Geographic distribution of Ebola viruses may overlap with the range of the fruit bats. However, there is no evidence that it is present in Australian bats or other animals in Australia. There have been no cases in Australia (CDC, 2014b). *Reston ebola* virus occurs in the Philippines. This or other filoviruses might also exist in other locations (Spickler and Anna, 2014).

Table1: Species of Genus *Ebola virus* with their distribution and fatality rate.

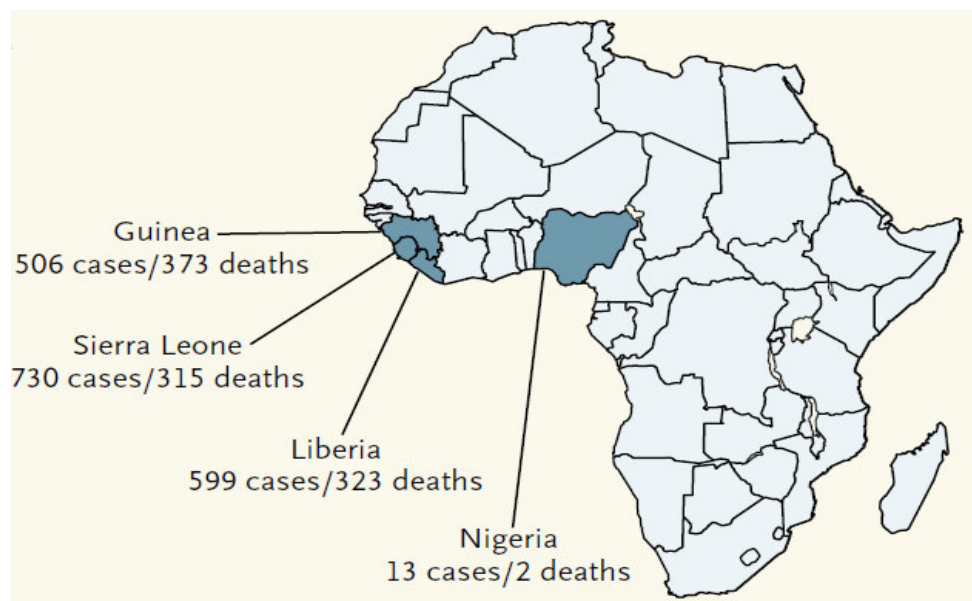| Species	Virus	Region	Fatality Rate
Zaire ebolavirus	EBOV	Africa	60-90%
Sudan ebolavirus	SUDV	Africa	40-60%
Bundibugyoebolavirus	BDBV	Africa	25%, based on one outbreak
Tai forest ebolavirus	TAFV	Africa	Unknown, only one known infection in Ivory Coast
Reston ebolavirus	RESTV	Asia	Not known to cause lethal infections in humans.

Source: (Semalulu *et al.,* 2014)

Figure-2: Recent geographical distribution of EVD in four African countries. Source: (Anthony and Fauci, 2014)

2.3.2. Host range / susceptible species

a) Natural host of Ebola virus

Fruit bats of the *Pteropodidae* family are considered to be the natural host of the Ebola virus. Although non-human primates have been a source of infection for humans, they are not thought to be the reservoir but rather an accidental host like human beings. Since 1994, Ebola outbreaks from the EBOV and TAFV species have been observed in chimpanzees and gorillas (Olival *et al*., 2013). Therefore, monkeys are not considered as natural hosts because of their high sensitivity to the virus and their high mortality rate when infected (Radford and Scott, 2014).

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 (Weingartl *et al.,* 2013). Non-human primates are in general highly susceptible to filovirus infections. Large outbreaks of lethal Ebola virus infections have been reported in wild populations of gorillas (*Gorilla gorilla*) and chimpanzees (*Pan troglodytes*) (Elias *et al.,* 2014). Other animals such as duikers (a species of forest antelope, *Cephalophusdorsalis*), bush pigs (red river hog, *Potamochoerusporcus*) are also affected (Spickler and Anna, 2014).

2.3.3. Risk factors

How filoviruses are transmitted between bats, or transmitted from bats to other animals or human, is still uncertain. Although these viruses can be found in bat tissues and blood, they typically seem to be absent from secretions or excretions such as oral fluids, urine and feces. There is some evidence that transmission might occur when bats give birth. Seasonal changes in the prevalence of *Marburg virus* RNA were reported in older juvenile Egyptian fruit bats, with peaks during the twice-yearly birthing seasons. These peaks seem to coincide with a higher risk of human infection. Pregnant fruit bats are also more likely to be seropositive than nonpregnant females (Spickler and Anna, 2014).

Although canine infection by Ebola virus has never been documented, domestic dogs' behavior and diet place them at risk. Several dogs were highly exposed to Ebola virus by eating infected dead animals. Transmission among chimpanzees through meat consumption constitutes a significant risk factor, whereas contact between the animals, such as touching dead bodies and grooming is not (Loïs *et al.,* 2005).

2.3.4. Transmission

Epidemics of Ebola virus disease are generally thought to begin when an individual becomes infected through contact with the meat or body fluids of an infected animal. Once the patient becomes ill or dies, the virus then spreads to others who come into direct contact with the infected individual's blood, skin, or other body fluids. Studies in laboratory primates have found that animals can be infected with Ebola virus through droplet inoculation of virus into the mouth or eyes (Jaax *et al.,* 1996).

Ebola is not spread through the air, by water, or in general, by food. However, in Africa, Ebola may be spread as a result of handling bushmeat (wild animals hunted for food) and contact with infected bats. There is no evidence that mosquitoes or other insects can transmit Ebola virus. Only a few species of mammals (e.g., humans, bats, monkeys, and apes) have shown the ability to become infected with and spread Ebola virus (CDC, 2015).

a) *Animal to human*

Although it is not entirely clear how Ebola initially spreads from animals to humans, the spread is believed to

involve direct contact with an infected wild animal or fruit bat. Besides bats, other wild animals sometimes infected with EBOV include several monkey species, chimpanzees, gorillas, baboons and duikers. In Africa, wild animals including fruit bats are hunted for food and are referred to as bush meat. In equatorial Africa, human consumption of bush meat has been linked to animal-to-human transmission of diseases, including Ebola (Sarah, 2014).

b)   Human to human

Person-to-person transmission follows and can lead to large numbers of affected people. In some past Ebola outbreaks, primates were also affected by Ebola and multiple spillover events occurred when people touched or ate infected primates. When an infection occurs in humans, the virus can be spread to others through direct contact through broken skin or mucous membranes in, for example, the eyes, nose, or mouth with blood or body fluids including but not limited to urine, saliva, sweat, feces, vomit, and breast milk of a person who is sick with or has died from Ebola, objects like needles and syringes that have been contaminated with body fluids from a person who is sick with Ebola or the body of a person who has died from Ebola, infected fruit bats or primates (apes and monkeys), and possibly from contact with semen from a man who has recovered from Ebola for example, by having oral, vaginal, or anal sex (CDC, 2014b).

Dead bodies remain infectious; thus, people handling human remains in practices such as traditional burial rituals or more modern processes such as embalming are at risk. No spread by mosquitos or other insects has been reported (Chan, 2014).

c)   Among non human primates/domestic animals

The extent of transmission between nonhuman primates during outbreaks in the wild is controversial; however, current evidence suggests that these viruses are not spread efficiently, and nonhuman primates are unlikely to act as maintenance hosts. Virus spread is likely to depend on the extent of interactions between members of the population, as well as the infectivity of body fluids and carcasses. Domestic animals become infected when they eat fruit partially eaten by bats carrying the virus. Fruit production, animal behavior and other factors may trigger outbreaks among animal populations. Evidence indicates that both domestic dogs and pigs can also be infected with EBOV (Spickler and Anna, 2014).

3. Infections in Animal

Although its clinical course is well known, the specific mechanisms underlying the pathogenicity of Ebola virus have not been clearly delineated. This is due, in part, to the difficulty in obtaining samples and studying the disease in the relatively remote areas in which the outbreaks occur. In addition, a high degree of biohazard containment is required for laboratory studies and clinical analysis (Sullivan *et al.,* 2003).

3.1. Incubation Period

Experimental inoculation of nonhuman primates with filoviruses often results in clinical signs after 3-5 days, although the incubation period was reported to be as long as 16 days in some animals. Pigs developed a fever 4 days after inoculation with *Zaire ebolavirus* (Murphy, 2014).

3.2. Pathogenesis

Experimental evidences show that the pathologic alterations found in Ebola virus infection of man and experimental animals are similar. Ebola viruses have all been associated with hemorrhagic fever in humans and/or non-human primates with differences in pathogenicity (Chepurnov *et al.,* 2001).

The virus first attacks and invades dendrites cells that alert the body to infection. By doing this, the virus can evade the immune system and begin replicating itself. Infected cells rupture, releasing more virus particles into the body as well as a flood of cytokines molecules that cause fever and inflammation. This "cytokine storm" damages blood vessels and causes internal bleeding. Certain white blood cells called neutrophils, which would normally fight an infection, can act as carriers and spread the Ebola virus throughout the body. After the virus has spread through the body, death is most often attributed to severe blood loss and massive organ failure (WHO, 2014).

3.3. Clinical Signs

Symptoms may appear anywhere from 2 to 21 days after exposure to Ebola, but the average is 8 to 10 days (CDC, 2014a). African species of *Ebolaviruses* are usually more pathogenic than *Reston ebolavirus*: the clinical signs are more severe, hemorrhages are more common and the mortality rate is higher (Spickler and Anna, 2014).

In humans, initial symptoms are nonspecific - may include fever, chills, myalgias, and malaise. Patients can progress to develop gastrointestinal symptoms: severe watery diarrhea, nausea, vomiting and abdominal pain. Bleeding not universally present but can manifest later as petechiae, ecchymosis/bruising, or oozing. Frank hemorrhage is less common. Some develop diffuse erythematous maculopapular rash that can desquamate (CDC, 2014c).

Nonhuman primates are severely affected by filoviruses. Wild chimpanzees and gorillas are often found

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dead. Clinical signs observed in dying wild animals (of various species) during Ebolavirus outbreaks have included vomiting, diarrhea, hair loss and emaciation, as well as bleeding from the nostrils (Gary, 2005).

Clinical signs in pig include high fever 41ºC, labored breathing, coughing, nasal discharge, loss of appetite, diarrhea and skin hemorrhage/reddish discoloration. Some found in recumbent position. Sows previously affected by high fever and abortions. Piglets inoculated with *Zaire ebolavirus* developed a fever and respiratory signs, which progressed to dyspnea, anorexia and lethargy. Guinea pigs infected with unpassaged filoviruses from primates may have a fever and weight loss, but recover. In this species, severe illness is only seen in animals infected with serially passaged virus adapted to guinea pigs. No clinical signs have been reported in infected wild bats and dogs (Goldsmith and Zaki, 2010).

3.4. Post Mortem Lesions

Petechiae, ecchymoses and frank hemorrhages may be present at necropsy. Hemorrhages can occur in any organ, but they are particularly common in the gastrointestinal tract, kidneys, and pleural, pericardial and peritoneal spaces. The liver and spleen may be swollen and friable, and the liver may be severely reticulated and discolored. Other potential lesions include interstitial pneumonia, nephritis, as well as necrosis of the liver, lymphoid tissue, adrenal cortex or pulmonary epithelium (Spickler and Anna, 2014). The right atrium was hemorrhagic in some animals, although the cause of this lesion was uncertain. Mild lung and lymph node lesions were reported in some asymptomatic piglets infected with *Reston ebolavirus*. The gross lesions in young pigs experimentally infected with *Zaire ebolavirus* were pulmonary consolidation and enlargement of the lung-associated lymph nodes, which were sometimes mildly hemorrhagic (Peter et al., 1994).

3.5. Diagnosis and Treatment

The diagnosis of EVD is confirmed by isolating the virus, detecting its RNA or proteins, or detecting antibodies against the virus in a blood. Isolating the virus by cell culture, detecting the viral RNA by polymerase chain reaction (PCR) and detecting proteins by enzyme-linked immunosorbent assay (ELISA) are methods best used in the early stages of the disease. Detecting antibodies against the virus is most reliable in the later stages of the disease and in those who recover (Grolla *et al.,* 2005).

During an outbreak, isolation of the virus via cell culture methods is often not feasible. In field or mobile hospitals, the most common and sensitive diagnostic methods are real-time PCR and ELISA. Filovirions, such as EBOV, may be identified by their unique filamentous shapes in cell cultures examined with electron microscopy, but this method cannot distinguish the various Filoviruses. In primates, Filoviruses occur in high concentrations in the liver, spleen, lungs, lymph nodes and skin. Liver, spleen, muscle and skin have been taken from wild animal carcasses in good condition for surveillance by RT-PCR. In bats, filoviruses have been found in tissues such as the liver and spleen, and sometimes in the blood. Electron microscopy can identify virus particles, which have a distinctive, filamentous pleomorphic, appearance, in tissues (Spickler and Anna, 2014).

The most important differential for EVD in humans and non-human primates is Marburg virus which is a related virus that causes hemorrhagic fevers (Grolla *et al.,* 2005). African swine fever, *classical swine fever, hemorrhagic gastroenteritis toxic shock syndrome* and gram-negative bacteria septicemia in pigs are also associated with hemorrhage (SFDPH, 2008). In human diseases like influenza, measles, rubella, dengue hemorrhagic fever, hemorrhagic varicella, hemorrhagic smallpox, shigellosis, *Chlamydia* infection, borreliosis, leptospirosis, rickettsiosis, hantavirus pulmonary syndrome and malaria are some of diseases associated with hemorrhagic fever (WHO, 2014).

Most Filovirus infections are serious and often fatal in both humans and nonhuman primates, infected animals are usually euthanized (Oestereich *et al.,* 2014).

There's no cure for Ebola, though researchers are working on it. Currently, the treatment of EVD includes an experimental serum that destroys infected cells, the administration of supportive care and treatment strategies such as fluids and electrolytes,oxygen, blood pressure medication, blood transfusions and treatment for other infections (Brunilda, 2014).

The WHO declared that, considering the magnitude and severity of the current outbreak, it is ethical to use experimental drugs for treatment and prevention of EVD. Zmapp is a cocktail of monoclonal antibodies and is being used to treat some victims of the current EBOV outbreak. Its role in treatment of EVD still needs to be established since efficacy data in humans have not been published yet. The strongest evidence that Zmapp is indeed effective in EVD comes from experiments in non-human primates in which Zmapp was able to revert advanced EVD when administered up to five days post infection (Quix *et al.,* 2014). Recently, the drug gained approval in Japan for use in humans infected with novel and re-emerging influenza viruses. Besides activity against influenza virus infection, this drug also has documented activity against a wide variety of RNA viruses including Ebolaviruses (Smither *et al.,* 2014).

Hemopurifier is another alternative way of treatment for Ebola virus patient.The Hemopurifier is a single-use disposable cartridge designed for use with dialysis machines and other blood circulatory pumps. It functions

to selectively remove harmful substances from the blood, giving a potential method of addressing diseases. During October 2014 the Hemopurifier was used as an adjunct in the treatment of a patient who was suffering from Ebola, who subsequently recovered (FDA, 2014).

3.6. Control and Prevention

3.6.1. Disease reporting

Animals that may be infected with Ebola viruses must be reported immediately, to protect humans who may be exposed and aid in controlling the outbreak (Spickler and Anna, 2014).

3.6.2. Good food preparation practices

Ebola viruses, as well as other microbes, are not transmitted through consumption of well-cooked food. Ebola viruses are inactivated by normal temperatures used for cooking (so that food reaches 60 °C in all parts "piping" hot); it is safe to eat properly prepared and cooked meat. Proper food preparation includes hand washing before and after handling food, hand washing in between handling raw food and cooked or ready-to eat food, keeping raw meat separate from cooked or ready-to-eat foods, keeping utensils and surfaces used to prepare raw meats separate from those used for other foods (e.g. chopping boards, knives and plates); and washing and disinfecting all surfaces and utensils that have been in contact with raw meat (WHO, 2014).

3.6.3. Animal testing for Ebola virus

Currently, routine testing for Ebola is not available for animals. Ebola virus testing of animal samples will be limited to cases where testing is specifically warranted based on the type of exposure assessment in consultation with Centers for Disease Control and Prevention (CDC) on a case-by-case basis. No samples will be tested without pre-authorization from CDC. In the event that an animal has a confirmed positive RT-PCR for Ebola virus RNA, the animal should be euthanized and the body incinerated (AVMA, 2014).

3.6.4. Routine cleaning and disinfection

Since, no animal vaccine against the virus is available. Routine cleaning and disinfection of pig or monkey farms (with sodium hypochlorite or other detergents) should be effective in inactivating the virus (WHO, 2014).

3.6.5. Quarantine, biosecurity measures and culling of infected animals

Quarantine of nonhuman primates during importation protects humans and healthy nonhuman primates from exposure to filoviruses. During outbreaks, suspects and exposed animals should be isolated, and euthanized after confirmation of the disease. Strict infection control procedures are necessary to prevent virus transmission on fomites. If an outbreak is suspected, the premises should be quarantined immediately. Measures to prevent infection of swine with Reston ebolavirus in endemic areas have not yet been established, but normal biosecurity measures should be helpful. Pigs should not be allowed to contact bats or nonhuman primates. Culling of infected animals, with close supervision of burial or incineration of carcasses, may be necessary to reduce the risk of animal-to-human transmission. Restricting or banning the movement of animals from infected farms to other areas can reduce the spread of the disease (WHO, 2014).

4. States of Evd in Ethiopia and the Major Control Measure Taken

Following the outbreak in Guinea, Sierra Leone, Liberia and Nigeria, Ebola virus disease (EVD) was declared as a public health emergency of international concern by the WHO Director General on 8 August 2014. The Federal Ministry of Health (FMoH) has taken the necessary measures to prevent the spread of Ebola virus disease to Ethiopia. The Government high-level task force is chaired by the Deputy Prime Minister on behalf of the Prime Minister, and the high-level task force involving different partners is chaired by the Minister of Health. FMoH held an orientation workshop on 6 August on Ebola virus disease outbreak preparedness and response to health workers on surveillance (case detection and reporting), risk factors, clinical signs and symptoms and precautions to be taken for infection prevention. More than 200 health workers from government and private hospitals, NGOs, health centers, health bureaus and sub-cities in Addis Ababa and Ethiopian Airlines Clinic attended the orientation. Also present were representatives from the WHO, the US Center for Disease Control and Prevention (CDC) and Japan Embassy (WHO, 2014).

There is no report of Ebola virus disease in Ethiopia so far. Screening for cases and high risks has been established at Bole International Airport for the travelers from West Africa particularly affected by the epidemic. The screening is expanding to the major land ports these days. Screening all others who have travel history to affected countries at 8 major land crossing: Moyale, Togowachale, Dewale, Galafi, Humera, Metema, Kumruk and Gambella. Training of rapid response team, focal persons and clinicians from regional hospitals, allocation of transportation service, personal protective equipments, infection prevention materials, isolation center, laboratory supplies and free calling service (8335) for rapid information and report of any suspected cases are some major preparation take by Ministry of Health in Ethiopia (Daddi, 2014).

As January 15, 2015, an Ethiopian patient suspected to have been suffering from Ebola died in the capital, Addis Ababa, on Wednesday. The patient, who recently returned from Sierra Leone, one of the worst-hit West African countries, was quarantined following his arrival at Addis Ababa Airport two weeks ago after showing

Ebola-like symptoms. However, Ethiopian health minister Dr Keseteberhan Admassu on Thursday has dismissed speculation the patient had died of Ebola, saying tests had confirmed he was not infected with the virus (Tesfalem, 2015).

5. Public Health and Economic Importances

Ebola virus disease is an important zoonotic disease (except Ebola- Reston) and currently its outbreaks constitute a major public health issue in western Africa. Just how Ebola actually gets from animals or the environment and into humans is unclear. The virus probably "resides" in bats. From there it may occasionally infect humans that directly handle or eat bats. Humans may find the dead "intermediate" animal and then eat its meat ("bushmeat"). Either way, in each outbreak, the first human to be infected is called the "index case". This person can then infect others, especially in areas where hygiene, sanitation and infection control levels are low. Researchers believe that the first patient becomes infected through contact with an infected animal. When an infection does occur in humans, the virus can be spread in several ways to others (Goldsmith and Zaki, 2010).

Reflecting alarmism owing to the disease, as well as EVD-related mortality and morbidity, economic activity has shrunk. This contraction reflects multiple cross-currents, falling sales in markets and stores, lower activity for restaurants, hotels, public transport, construction and educational institutions (also caused by government measures such as a state of emergency and restrictions on people's movements) and slowing activity among foreign companies as many expatriates leave, with a knock on felt in lower demand for some services (United Nations Economic Commission for Africa, 2014). Households have less access to basic goods on the market because of reduced incomes resulting in a change in eating habits; supply of goods is constrained due to border and market closures, as well as transportation problems; and challenges in the agricultural sector may affect farmers' ability to have a normal harvest in the upcoming planting seasons. Some of these issues may have immediate remedies, while others will require medium to long-term interventions (Monrovia, 2014).

With a large expansion of the outbreak, and Ebola spreading to other countries in the region, children would lose their providers, households would suffer losses to their income, businesses would lose workers to death, illness, and fear, and industries like mining and agriculture would slow down significantly. Ebola virus outbreaks also provide dreadful publicity for tourism and investment (Leroy et al., 2004).

6. Conclusion and Recommendations

In conclusion, very little is known about how domestic animals respond to Ebola virus and there is no evidence that domestic animals play an active epidemiological role in the transmission of the disease to humans. The only domestic animals that have been found to be susceptible to Ebola viruses are dogs and pigs. Dogs showed little to no discernible symptoms of the virus; while pigs showed mild to severe symptoms. The asymptomatic infection of dogs by Ebola virus in the wild has potential implications for preventing and controlling human outbreaks. Wild animals such as fruit bats, non human primates, duikers and bush pigs are affected by Ebola virus disease with fruit bat and non human primates are the potential source for human infection. However, non human primates are not considered as natural hosts because of their high sensitivity to the virus and their high mortality rate when infected. Therefore, fruit bats are considered to be the only natural host of the Ebola virus. How filoviruses are transmitted between bats, or transmitted from bats to other animals or human, is still uncertain. There is some evidence that transmission might occur when bats give birth. Domestic animals become infected when they eat fruit partially eaten by bats carrying the virus. People can become sick with Ebola after coming in contact with infected bats and handling or consuming of bushmeat.

Based on the above conclusions, the following recommendations are forwarded:-

➢ It is important to step up wildlife monitoring activities and develop operational cooperation between animal health services and public-health authorities to ensure early warning of possible human Ebola outbreaks.

➢ As soon as there are rumours of animal die-off, national park services (or veterinary services) should take specimens from dead animal carcasses for diagnostic purposes, using protective equipment. The specimens must be sent to a reference laboratory for analysis. As soon as animal cases are confirmed, animal health services must alert the public health authorities so they can put in place programmes to prevent a human outbreak.

➢ Here in Ethiopia, studies should be conducted on the presence and distribution of fruit bats together with the seroprevalance of the disease within it since it is very serious and can result in human outbreaks.

➢ Further studies should be needed to investigate the possible natural host, susceptible animal species and way of transmission of the disease and so as to establish the possible control measures for the disease.

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