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# Ebola Virus Disease in Africa: Recurrent Outbreaks, Continuing Public Health Threat, Medical Countermeasures, and One Health Perspectives

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**Abstract** Ebola virus disease (EVD) is a zoonotic disease of great public health importance. It is characterized by a high case fatality rate, causes outbreaks, and can lead to major social and economic disruption. First recognised in 1976 in Sudan and the Democratic Republic of the Congo, the disease has since emerged in different parts of Africa. The most significant outbreak occurred between 2014 and 2016 in West Africa. EVD is caused by species of the genus *Orthoebolavirus*, including Ebola virus, Sudan virus, and Bundibugyo virus. These viruses differ in fatality rates and in the availability of medical countermeasures. Fruit bats are believed to be the natural reservoir. Transmission to humans occurs through contact with infected animals, body fluids of infected persons, and contaminated environments, including during unsafe burial practices. The early stages present with non-specific symptoms, followed by gastrointestinal and hemorrhagic symptoms. Laboratory confirmation involves molecular, antigen-based, serological, and virological methods. Treatment options include supportive care, monoclonal antibodies for cases caused by *Orthoebolavirus zaire*, and vaccination. However, major gaps remain in the treatment and prevention of Sudan and Bundibugyo virus infections. Despite progress in EVD management, further research is needed to improve preparedness, diagnosis, treatment, and control. Therefore, this review discusses the etiology, epidemiology, transmission, pathogenesis, clinical spectrum, diagnosis, treatment, control, and One Health implications of Ebola virus disease, while highlighting existing knowledge gaps and future research needs.

***Keywords:*** *Ebola virus, Orthoebolavirus, One Health, Zoonotic disease, Africa*

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## 1. Introduction

Ebola virus disease (EVD), earlier known as Ebola haemorrhagic fever, is a severe and often fatal zoonotic viral disease of major public health concerns. It is caused by viruses belonging to the genus *Orthoebolavirus* in the family *Filoviridae* [1]. These viruses are enveloped, filamentous, non-segmented, negative-sense RNA viruses that are capable of causing outbreaks with high morbidity and mortality in humans and non-humans' primates [2]. The disease was first recognized in 1976, during two near-simultaneous outbreaks in Sudan and Zaire, now the Democratic Republic of the Congo, with the latter occurring near the Ebola River, from which the virus derives its name [3,4]. The published review EVD as a highly contagious zoonotic disease, emphasizing the role of the fruit bats and non-human primates in virus maintenance and transmission, as well as the importance of surveillance, diagnosis, biosecurity, and preparedness [5,6]. Six *Orthoebolavirus* species are currently recognized: *Orthoebolavirus zairense* associated with Ebola virus, *Orthoebolavirus sudanense* associated with Sudan virus, *Orthoebolavirus bundibugyoense* associated with Bundibugyo virus, *Orthoebolavirus taiense* associated with Tai Forest virus, *Orthoebolavirus restonense* is associated with Reston virus, while *Orthoebolavirus bombaliense* is associated with Bombali virus. Among these, Ebola virus, Sudan virus, and Bundibugyo virus are known to cause large outbreaks in humans [7]. WHO states that Ebola disease is severe and often fatal, with average case fatality around 50%, although past outbreaks have ranged from 25% to 90% [8].

EVD is primarily a zoonotic infection, and available evidence suggests that fruit bats are probable natural reservoirs of *Orthoebolavirus*. Spillover to humans may occur through direct contact with infected wildlife, including bats, non-human primates, forest antelopes, or other animals found ill or dead in forest environments [9].

Human-to-human transmission occurs through direct contact with blood, secretions, organs, or other body fluids of infected persons, as well as contaminated materials and unsafe burial practices. In particular, healthcare workers are at risk when infection prevention and control measures are insufficient [10]. Published reports have also identified Ebola virus–specific antibodies and viral RNA in several species of fruit bats, consistent with a possible role for fruit bats as reservoirs [11]. Clinical presentation of EVD is characterised by nonspecific symptoms such as fever, fatigue, headache, myalgia, sore throat, vomiting, diarrhoea, and abdominal pain that may progress to haemorrhagic manifestations, shock, multiorgan dysfunction, and death [12]. Early signs are like malaria, typhoid, shigellosis, meningitis and other viral haemorrhagic fevers and laboratory confirmation is needed [13]. Reverse transcription polymerase chain reaction (RT-PCR), antigen-detection assays, antibody-capture ELISA, and virus isolation remain important diagnostic approaches, although handling of suspected specimens requires strict biosafety precautions. WHO highlights RT-PCR, antigen-capture tests, antibody-capture ELISA, and virus isolation as diagnostic methods and notes that patient samples are an extreme biohazard risk [14].

The 2014-2016 West African epidemic was the largest Ebola outbreak recorded to date, causing more than 28,600 reported cases and over 11,300 deaths, and exposing major gaps in surveillance, preparedness, laboratory capacity, infection prevention, and community engagement [15]. Since then, outbreaks have continued to occur in Central and East Africa, including the 2025 Sudan virus disease outbreak in Uganda and the 2026 Bundibugyo virus disease outbreak involving the Democratic Republic of the Congo and Uganda [16]. In May 2026, WHO declared the Bundibugyo virus disease outbreak in DRC and Uganda a Public Health Emergency of International Concern, reflecting the risk of regional and international spread, the involvement of health care workers, and the absence of licensed Bundibugyo-specific vaccines or therapeutics [17]. EVD clearly illustrates the importance of the One Health approach, as its emergence and spread are shaped by interactions among humans, animals, wildlife, health-care systems, cultural practices, mobility, and environment change [18]. The role of veterinarians and allied public health professionals is especially important in zoonotic disease surveillance, wildlife monitoring, risk assessment, food safety, biosecurity, public education, and outbreak preparedness [19]. The published One Health paper emphasizes that veterinarians are central to disease prevention, surveillance, environmental stewardship, and sustainable health systems, and that integrated surveillance across human, animal, and environmental sectors improves early detection of zoonotic threats [20].

Therefore, EVD remains a continuing global health challenge despite advances in diagnostics, supportive care, vaccination for Ebola virus disease, and outbreak response systems. Recurrent outbreaks, viral persistence in survivors, ecological uncertainty regarding reservoirs, health-care-associated transmission, and gaps in preparedness demonstrate the need for sustained surveillance and multidisciplinary collaboration. This review summarizes that etiology, natural reservoir, epidemiology, transmission, pathogenesis, clinical features, diagnosis, treatment, prevention, control strategies, and One Health implications of EVD, current challenges with emphasis on strengthening preparedness and coordinated response to reduce the impact of future outbreaks.

## 2. Etiology and Viral Classification

Ebola virus disease is caused by infection with *Orthoebolavirus*, a group of enveloped, filamentous, non-segmented, negative-sense single stranded RNA viruses belonging to the family *Filoviridae.* Members of this family are known for their thread-like morphology, high pathogenic potential, and ability to produce severe viral haemorrhagic disease in humans and non-human primates. The virions are pleomorphic and may appear as long filaments, branched structures, or U-shaped particles [21]. The viral genome is approximately 19kb in length and encodes seven major structural and functional proteins, namely nucleoprotein (NP), viral proteins such as viral protein 35 (VP35), viral protein 40 (VP40), viral protein 30 (VP30) and viral protein 24 (VP24), glycoprotein (GP), and RNA-dependent RNA polymerase (L). These proteins are essential for viral attachment, entry, replication, assembly, budding, and immune evasion [22].

Proteins that make up the structure of the Ebola viruses play an integral role in their ability to infect cells and cause a serious illness. The surface glycoprotein plays an important role in attaching to cells and invading them. Once the cells are infected, other viral proteins help in the replication and regulation of the immune system response. Two specific proteins called VP35 and VP24 inhibit the interferon-mediated immune response and thus promote the replication of viruses before the host's immune system has time to respond [23]. Another protein VP40 acts as a matrix protein involved in assembly and release of the virions. And, finally, the L protein acts as an RNA-dependent RNA polymerase required for viral genome replication [24,25]. Taxonomically, Ebola viruses are classified under the genus *Orthoebolavirus* in the family *Filoviridae.* Six species are currently recognized, namely *Orthoebolavirus zairense, Orthoebolavirus sudanense, Orthoebolavirus bundibugyoense, Orthoebolavirus taiense, Orthoebolavirus restonense, and Orthoebolavirus bombaliense,* which correspond to Ebola virus, Sudan virus, Bundibugyo virus, Tai Forest virus, Reston virus, and Bombali virus, respectively [26]. Among these, Ebola virus, Sudan virus, and Bundibugyo virus have caused the most important human outbreaks, with Ebola virus being responsible for the largest and most devastating epidemic in West Africa during 2014-2016. Tai Forest virus has been linked with human infection, but only rarely [27]. Reston virus has mainly been reported in non-human primates and pigs and has not been associated with severe human disease, while Bombali virus has been detected in bats and its public health significance remains unclear. The zoonotic origin of Ebola virus disease is therefore a key part of its etiology, with fruit bats considered the most likely natural reservoirs [8]. Other wildlife, including non-human primates, forest antelopes, and porcupines, may become infected and serve as intermediate or incidental

hosts. Human infection typically starts after contact with infected wildlife, carcasses or body fluids, followed by person-to-person transmission through blood, secretions, organs and other body fluids. Thus, proper viral classification is important not only for taxonomy but also for diagnosis, outbreak investigation, vaccine use, therapeutic planning, and public health preparedness [12].

## 3. Natural Reservoirs and Animal Hosts

Ebola virus disease is a zoonotic disease and fruit bats are widely considered the most likely natural reservoir hosts of Ebola viruses [28]. The detection of Ebola virus RNA and virus-specific antibodies in several fruit bat species supports this association and suggests their possible role in maintaining the virus in nature. Non-human primates including gorillas, chimpanzees and monkeys, and forest antelopes, porcupines and other wild animals may be infected but are considered as intermediate or incidental hosts rather than true reservoirs [7]. Humans are commonly infected after contact with infected wildlife, their carcasses or body fluids, particularly when hunting, handling, slaughtering or consuming bush meat [29]. Increased contact between humans and wildlife, along with deforestation, habitat encroachment and population movement, all contribute to a higher risk of spillover from animals to humans [30].

## 4. Epidemiology and Geographical Distribution

Ebola virus disease was first reported in 1976, in two almost simultaneous outbreaks in Sudan and Zaire, now Democratic Republic of Congo [3]. Since then, re-emergence of the disease has been reported mainly in Central and West Africa, notably in Democratic Republic of Congo, Uganda, Sudan, South Sudan, Goban, Republic of Congo, Guinea, Liberia and Sierra Leone. The largest outbreak was in West Africa (2014–2016), primarily in Guinea, Liberia and Sierra Leone, with >28,600 cases and >11,300 deaths [31]. Recent outbreaks demonstrate that Ebola virus disease continues to be a threat to public health. Sudan virus disease was reported in Uganda in 2025. Bundibugyo virus disease was reported in the Democratic Republic of Congo in 2026 with spread to Uganda. The 2026 outbreak occurred in eastern DRC, including the provinces of Iturbi, Nord-Kivu, and Sud-Kivu, and in one affected district in Kampala, Uganda [20]. This cross-border distribution highlights the need for strong surveillance, early diagnosis, contact tracing, infection control, and coordinated regional response as shown in Figure 1 [32].

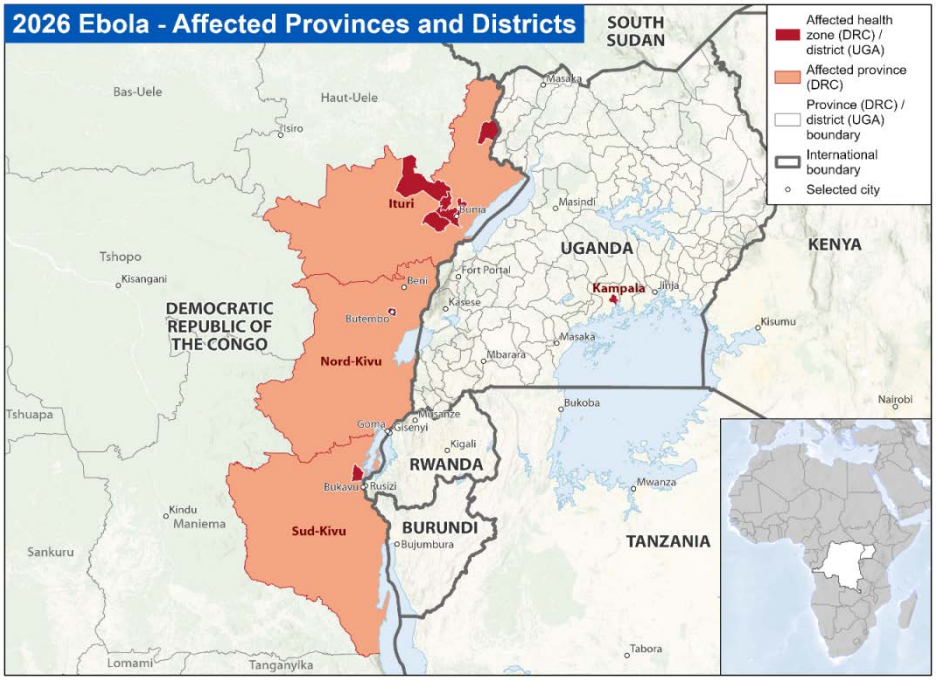


**Figure 1.** Geographical distribution of affected provinces and districts during the 2026 Bundibugyo Ebola disease outbreak in the Democratic Republic of Congo and Uganda. Source: [32]

## 5. Transmission and Risk Factors

### 5.1. Animal-to-human Transmission

Ebola virus disease usually begins with zoonotic spillover from infected wildlife to humans. Infection may occur during hunting, handling, slaughtering, or consumption of bushmeat, especially when people come into contact with blood, tissues, organs, or body fluids of infected animals [29]. Bats, non-human primates, forest antelopes, and other wild animals have been linked with Ebola virus transmission [33].

### 5.2. Human-to-human Transmission

After the virus enters the human population, transmission occurs mainly through direct contact with

infected body fluids. Blood, vomitus, urine, faeces, saliva, sweat, breast milk, semen, and other secretions may contain infectious virus, particularly during the symptomatic phase of disease. Family members and caregivers are at high risk when protective measures are not followed [18].

### 5.3. Contaminated Materials and Fomites

Ebola virus may also spread through contaminated needles, syringes, medical instruments, bedding, clothing, and other materials soiled with infectious body fluids. Reuse of needles or poor sterilization practices can amplify transmission, especially in healthcare arrangements with limited resources [31].

### 5.4. Unsafe Burial Practices

Traditional burial practices are an important risk factors during outbreaks. Washing, touching, or preparing the body of a person who died from Ebola can expose relatives and community members to highly infectious body fluids. Safe and dignified burial is therefore essential for outbreak control [12].

### 5.5. Healthcare-associated Transmission

Healthcare workers face a high risk of infection when caring for suspected or confirmed cases without adequate personal protective equipment. Poor infection prevention, delayed diagnosis, overcrowded treatment areas, and improper handling of specimens can contribute to hospital-based transmission [34].

### 5.6. Sexual Transmission from Survivors

Ebola virus can persist in immune-protected sites after recovery, especially in semen. Sexual transmission from male survivors has been reported months after clinical recovery; therefore, survivor counselling, semen testing where available, and safe sexual practices are important parts of post-outbreak control [35].

## 6. Pathogenesis

Infection by Ebola virus occurs through mucosal surfaces, damaged skin, or parenterally, and begins with infection of monocytes, macrophages, and dendritic cells [21]. Once infected, the virus spreads via the lymphatic and blood vessels to local lymph nodes, the liver, spleen, adrenals, and other organs [42]. The viral proteins interfere with the actions of the innate immune system, including inhibition of antiviral effects mediated by interferon, allowing for replication and distribution throughout the body [5]. Cytokine storms caused by production of inflammatory cytokines and chemokines from infected immune cells lead to injury to the endothelium and increased vascular permeability [5]. Coagulation processes become highly disturbed during the course of the infection, leading to thrombocytopenia, disseminated intravascular coagulation, bleeding, and poor organ perfusion. Severely affected Ebola virus disease leads to hypovolemic shock, metabolic disturbances, multiple organ dysfunction syndrome, and death [37,38].

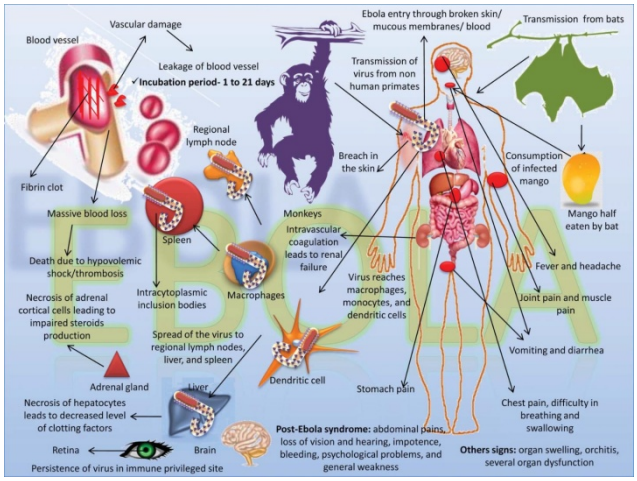


**Figure 2.** Transmission, pathogenesis, and clinical signs of Ebola virus Source: [12]

## 7. Clinical Spectrum

### 7.1. Early Disease

The incubation period of Ebola virus disease ranges from 2 to 21 days, with clinical signs most commonly appearing around 8-10 days after exposure. The early phase is usually abrupt and non-specific, presenting with sudden fever, headache, fatigue, myalgia, arthralgia, and sore throat [5]. Because these symptoms resemble other illness such as malaria, typhoid fever, dengue, and influenza-like infections, early clinical diagnosis is often difficult without laboratory confirmation [12].

### 7.2. Progressive Disease

As the infection advances, gastrointestinal and systemic manifestations become more prominent. Patients commonly develop vomiting, profuse diarrhoea, abdominal pain, conjunctivitis, and sometimes a maculopapular rash. Fluid loss due to vomiting and diarrhoea may rapidly lead to dehydration, electrolyte imbalance, weakness, and worsening clinical condition. At this stage, patients become highly infectious because body fluids contain large amounts of virus [29].

### 7.3. Severe Disease

Severe Ebola virus disease is marked by haemorrhagic manifestations, shock, neurological involvement, and multiorgan failure. Gastrointestinal haemorrhage, haematemesis, melaena, haematuria, and bleeding from mucosal surfaces may occur in advanced cases, although bleeding is not present in all patients. Progressive vascular leakage, coagulation disturbances, and impaired tissue perfusion contribute to hypovolemic shock and organ dysfunction. The average case-fatality rate is approximately 50%, but mortality may vary from 25% to 90% depending on the virus species, outbreak setting, timing of diagnosis, and quality of supportive care.

Survivors may develop long-term sequelae such as arthralgia, chronic fatigue, visual impairment, hearing loss, and neuropsychiatric complications [16].

## 8. Diagnosis and Differential Diagnosis

Early diagnosis of Ebola virus disease is challenging because the initial clinical features are non-specific and closely resemble several endemic illnesses. Fever, headache, fatigue, myalgia, vomiting, and diarrhoea may also occur in malaria, typhoid fever, dengue, leptospirosis, Marburg virus disease, and other viral haemorrhagic fevers. Therefore, clinical suspicion should be based on a combination of symptoms, travel or residence in an affected area, contact with a suspected or confirmed case, exposure to infected animals, or participation in burial rituals. In outbreak settings, every suspected case must be rapidly isolated and investigated to reduce the risk of further transmission [39].

Laboratory confirmation is essential for accurate diagnosis. Reverse transcription polymerase chain reaction (RT-PCR) and real-time RT-PCR are the most widely used methods for detecting Ebola viral RNA during acute infection. Antigen detection ELISA may be useful in early disease, while IgM and IgG antibody detection are more useful during later stages of infection or for sero-epidemiological studies [1]. Immunohistochemistry can help detect viral antigen in tissue samples, especially in fatal cases. Virus isolation is confirmatory but requires high-containment biosafety laboratories because clinical specimens from suspected patients are highly infectious. Strict biosafety precautions during sample collection, packaging, transport, and testing are therefore essential [40].

## 9. Treatment and Case Management

There is no single universal treatment that is effective against all Ebola virus species. Early supportive care remains the foundation of case management and can significantly improve survival when started promptly. Treatment includes correction of hydration level, fluid and electrolyte replacement, oxygen support, nutritional care, pain and fever management, and treatment of secondary bacterial infections or co-existing illnesses such as malaria. In severe cases, patients may require management of shock, bleeding, renal impairment, liver dysfunction, and multiorgan failure. Careful monitoring of vital signs, urine output, blood glucose, electrolytes, and organ function is important throughout the clinical course [41].

Specific monoclonal antibody therapies have improved the management of Ebola virus disease caused by Zaire ebolavirus. REGN-EB3, also known as Inmazeb, and mAB 114, also known as Ebanga or ansuvimab, have shown benefit in reducing mortality when administered early in the course of illness. However, these therapies are approved for disease caused by Ebola virus, corresponding to *Orthoebolavirus sudanense*, and are not considered universal treatments for all *Orthoebolavirus*. At present, there is no licensed species-specific therapeutic option for Sudan virus disease or Bundibugyo virus disease, making supportive care, early diagnosis, and outbreak control especially important for these infections [42].

## 10. Vaccines and Immunoprophylaxis

Vaccination has become an important component of Ebola outbreak response, particularly for disease caused by Zaire ebolavirus. The recombinant vesicular stomatitis virus vaccine, Ervebo or rVSV-ZEBOV, is used for the prevention of Ebola virus disease caused by Zaire ebolavirus and has been applied in outbreak settings through ring vaccination strategies [43]. Ring vaccination targets contacts, contacts of contacts, frontline health workers, and other high-risk groups around confirmed cases, thereby helping to interrupt chains of transmission. This approach is most effective when combined with rapid case detection, contact tracing, community engagement and infection prevention measures [44].

Despite this progress, important vaccine gaps remain crucial, approved vaccines do not provide broad protection against all Ebola virus species. Vaccine candidates for Sudan virus disease have been evaluated in outbreak and trials, but no licensed vaccine is currently available for routine prevention of Sudan virus disease [45]. Similarly, Bundibugyo virus disease lacks a licensed vaccine, which limits outbreak response options during events caused by this virus. Future research should therefore focus on developing safe, effective, and accessible vaccines against multiple *Orthoebolavirus*, especially Sudan virus and Bundibugyo virus [41].

## 11. Prevention and Control Measures

Prevention and control of Ebola virus disease require rapid, coordinated, and community-centred public health action. The first priorities during an outbreak are early case detection, laboratory confirmation, isolation of suspected and confirmed patients, and prompt contact tracing [8]. Contacts should be monitored for 21 days after their last exposure, and any person who develops symptoms should be immediately assessed and isolated. Active surveillance, rapid reporting, and field investigation are essential to identify transmission chains and prevent silent spread within communities [46].

In healthcare, strict infection prevention and control measures are critical. Healthcare workers should use appropriate personal protective equipment, follow safe procedures for patient care, and avoid direct contact with blood and body fluids without protection. Safe injection practices, proper disinfection, sterilization of instruments, waste management, and safe handling of clinical specimens are necessary to prevent hospital-based transmission. Ebola treatment units should be organized in a way that separates suspected, confirmed, and recovering patients to reduce cross-infection [47].

Community participation is equally important for successful outbreak control. Safe and dignified burial practices reduce exposure to highly infectious bodies while respecting local customs as much as possible. Public education should address symptoms, transmission routes, early reporting, safe caregiving, and avoidance of contact with infected wildlife or bushmeat. Cross-border

surveillance and travel or movement monitoring is also important during outbreaks, especially in regions with population mobility, trade, insecurity, or weak health infrastructure [47].

## 12. One Health Perspectives

The Ebola virus disease demonstrates the One Health concept in that it relates to the relationship between humans, animals, wildlife, and the environment. The fruit bat is thought to be the reservoir for the Ebola virus, but other wildlife species, such as non-human primates, forest antelopes, and porcupines, can also become infected [29]. Many of these animals are in contact with humans due to human activities that impact their natural environments and habitats, such as deforestation, mining, agriculture, hunting, and settlement or intermediate hosts. Environmental change, population movement, and climate-related ecological shifts may further influence the risk of emergence [30].

A One Health approach to Ebola prevention should integrate human health, veterinary, wildlife, and environmental sectors. Wildlife surveillance, bat population monitoring, ecological studies, and community education about safe wildlife contact are important for identifying and reducing spillover risks. Veterinarians, physicians, epidemiologists, ecologists, wildlife biologists, laboratory scientists, and public health workers should collaborate in surveillance, risk assessment, outbreak investigation, and response planning. Integrated human-animal-environmental surveillance can improve early warning systems and help detect unusual animal deaths, ecological changes, or human cases before outbreaks become widespread [14].

## 13. Current Challenges and Future Directions

Several challenges limit Ebola virus prevention and control. The ecology of the natural reservoir of Ebola viruses is not yet fully understood. Additionally, the symptoms of Ebola virus disease can be similar to those of other tropical diseases, making early diagnosis difficult. The lack of healthcare infrastructure in the affected regions can make response to Ebola outbreaks challenging. These regions may have limited access to medical facilities and laboratory testing, transportation issues, and a lack of health workers to treat patients with the virus. Additionally, the virus can remain in individuals who have survived an Ebola infection, leading to challenges in counselling and preventing the spread of the virus [10].

The future of preventing Ebola virus disease can include the development of rapid diagnostic tools for the virus, improving the healthcare infrastructure in affected areas, and providing training to health care workers. Additionally, research can be undertaken to develop vaccines and therapeutics for other ebolaviruses, such as the Sudan virus, Bundibugyo virus, and other members of the *Orthoebolavirus* genus. Through international cooperation and the efforts to implement One Health practices in affected regions, the future management of Ebola virus disease can be significantly improved [20].

## 14. Conclusion

Ebola virus disease is one of the most severe zoonotic viral diseases that affects Africa and poses a threat to global public health. Although there are various treatments and interventions for Ebola virus disease, including diagnostics, supportive care for infected individuals, monoclonal antibodies, and vaccines against Zaire ebolavirus, there is still much work to be done. The various outbreaks of Ebola caused by different *Orthoebolavirus* indicate that preparedness for such an illness should not be focused on just one species of the Ebola virus. The absence of licensed vaccines and therapeutics for Sudan virus disease and Bundibugyo virus disease is a major concern and requires urgent scientific attention. Control of Ebola virus disease depends on early detection, rapid laboratory confirmation, isolation of cases, contact tracing, safe burial, infection prevention, and community trust. Health systems in outbreak-prone regions should be strengthened through improved laboratory capacity, trained healthcare workers, adequate personal protective equipment, and emergency response planning. Greater investment is needed in broad-spectrum vaccines, antiviral agents, survivor follow-up and ecological research on reservoirs. Since Ebola emerges at the human-animal-environment interface, veterinarians and wildlife experts should be fully included in surveillance and preparedness programs. A coordinated One Health approach offers the most practical and sustainable strategy for reducing the risk and impact of future Ebola outbreaks.

## Abbreviations

EVD: Ebola Virus Disease
RNA: Ribonucleic Acid
RT-PCR: Real Time Polymerase Chain Reaction
ELISA: Enzyme Linked Immunosorbent Assay
WHO: World Health Organisation
DRC: Democratic Republic of Congo
NP: Nucleoprotein
VP: Viral Protein
GP: Glycoprotein

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## Contribution of Authors

All authors contributed significantly to the manuscript.

## Conflict of Interest

The authors declare no conflict of interest.

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