Marburg virus disease outbreak in Rwanda, 2024: Current efforts and calls to action to mitigate the outbreak in Rwanda

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ABSTRACT

The recent outbreak of Marburg virus disease (MVD) in Rwanda, first reported in September 2024, marks the country's initial encounter with this highly lethal hemorrhagic fever caused by the Marburg virus.

With primary transmission from fruit bats and subsequent human-to-human spread through direct contact, MVD presents significant public health challenges due to its rapid progression from flu-like symptoms to severe hemorrhagic fever and high mortality rates.

Rwanda's Ministry of Health responded swiftly, implementing critical containment measures, such as intensive contact tracing, targeted vaccination for suspected cases and healthcare providers, restricting caregiver access, limiting traditional gatherings, and enforcing strict hygiene and infection control protocols.

In the last three and a half years, Rwanda has been dealing with COVID-19, Mpox (formerly monkeypox), and now the Marburg outbreak. Drawing on lessons from past public health crises, Rwanda's Ministry of Health is implementing swift action to manage the situation. Here we discussed Rwanda's strategies in managing the MVD outbreak, emphasizing the importance of a One Health approach that integrates human, animal, and environmental health to mitigate zoonotic threats.

Vaccination efforts targeting healthcare providers and high-risk contacts have become a vital component of Rwanda's response, aiming to protect those on the front lines and prevent further spread. The response is further strengthened by partnerships with global health organizations, including the World Health Organization (WHO), underscoring the need for coordinated international support and cross-border containment measures.

This MVD outbreak highlights the urgency of ongoing research into effective treatments and licensed vaccines to bolster Rwanda's preparedness and resilience against future outbreaks.

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INTRODUCTION

Marburg Virus Disease (MVD) is a highly lethal infection; however, not all infected individuals develop severe hemorrhagic symptoms. Case fatality rates for MVD have ranged from 24% to

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88%, varying based on factors like virus strain, individual health conditions, and the timing of medical intervention [1,2]. Initial symptoms often include fever, headache, and gastrointestinal issues, with hemorrhagic symptoms generally occurring in more advanced cases rather than universally [3]. Factors such as viral load, age, and early medical support influence the likelihood of progression to severe hemorrhagic disease, meaning that not all cases result in hemorrhagic manifestations [4]. It is less common than Ebola virus disease, both of which belong to the filovirus family [3,5]. The primary reservoir hosts of MVDs are believed to be fruit bats, with transmission occurring from bats to humans, and through direct human-to-human contact. The disease has an estimated incubation period of 3–21 days [6]. Early symptoms include high fever, chills, nausea, diarrhea, vomiting, and general discomfort, which progress to severe hemorrhagic fever characterized by intense muscle pain, extensive bleeding, and, in some cases, multi-organ failure [7,8].

The initial outbreaks of MVD were recorded simultaneously in Germany and Serbia in 1967, when laboratory personnel was infected after exposure to African green monkeys. Since then, MVD has been reported in 17 countries [9,10]. On September 27, 2024, Rwanda's Ministry of Health reported the country's first-ever MVD outbreak. By the following day, health authorities had intensified their response efforts, confirming 26 cases and six fatalities [8,11]. Earlier on Sunday, September 29, Health Minister Dr. Sabin Nsanzimana announced that the government had identified around 300 individuals who had been in contact with those infected, all of whom were undergoing testing to check for the virus. "We have numerous contacts, and this number is likely to rise as we continue our tracing efforts. To date, nearly 300 people have been identified, and this number may increase due to varying levels of interaction. These individuals may have had casual contact, such as exchanging greetings, or more direct contact, like providing care or being a patient," Minister Nsanzimana stated [12].

As of October 24, 2024, 64 cases of Marburg virus disease had been reported in Rwanda, with 15 deaths (case fatality ratio (CFR) 23.4%). Among the first 62 confirmed cases with accessible data, 70% were men and 48% were aged between 30 and 39. For context, approximately 12.4% of Rwanda's population falls within the 30-39 year age group, highlighting the notable impact on this demographic. The first two epidemiological weeks of the outbreak saw the newest confirmed cases, with 26 cases recorded in week 39 (23-29 September 2024) and 23 cases recorded in week 40 (30 September-6 October). A significant decrease followed in the subsequent weeks [1]. By 30 October, 66 cases were confirmed, with 15 deaths from 5913 tests (Figure 1).

Numerous outbreaks of the Marburg virus (MARV) have occurred in Africa, although they have not attracted as much public attention as the Ebola virus [13]. Uganda experienced outbreaks in 2012, 2014, and 2017, reporting 15, one, and four cases, respectively [11,14]. The continent has faced epidemics beyond Uganda, with occurrences noted in central and southern Africa as well. Until the previous year, when the World Health Organization (WHO) confirmed Guinea's first case of MARV, West Africa had remained mostly unaffected by the virus [15]. Nonetheless, viral hemorrhagic disease outbreaks, particularly those caused by Ebola virus, have been reported in West Africa [16].

According to the Ministry of Health, a significant factor in this recent outbreak may be extensive contact with individuals from abroad, particularly from European countries, who have interacted with healthcare providers. These healthcare providers, who operate within a multidisciplinary system and regularly engage with colleagues, were identified as the most affected group at the onset of the outbreak.

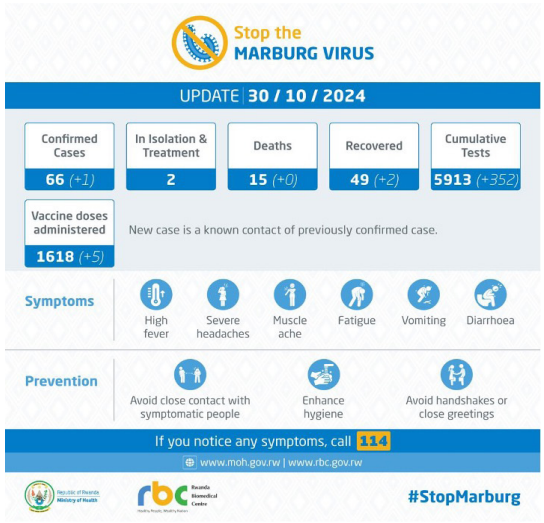

Figure 1: *MVD situation in Rwanda in October 2024*

The majority of those infected are health workers, especially those working in intensive care units [1,5].

EPIDEMIOLOGY OF MVD

Although the initial outbreak of MVD was reported in Europe, Africa has experienced several outbreaks, some manifesting as small clusters, while others have led to significant mortality and morbidity [17]. Notably, during the 1980 pandemic in Kenya, two cases were linked to an individual who visited the Kitum caves, a known habitat for bats. Additionally, three cases were recorded in the 1975 outbreak affecting Zimbabwe and South Africa [18]. The 2004–2005 outbreak in Angola had 374 confirmed cases, while the 1998–2000 outbreak in the Democratic Republic of the Congo had 154 confirmed cases, accompanied by an alarming mortality rate of 83% [19].

In 2007, the discovery of bats in a mining tunnel known to harbor the virus led four Ugandan workers to contract MVD. A subsequent fatal case was reported in 2014, followed by an additional 197 cases [20]. The Democratic Republic of the Congo, Kenya, and Uganda have also reported outbreaks and isolated cases recently [19].
The World Health Organization's risk assessment in 2012 indicated that Tanzania had a very high risk of recurrent infectious disease outbreaks. Between 2020 and 2023, Tanzania faced several significant health challenges, including the COVID-19 pandemic, cholera, and dengue outbreaks, and most recently, the MVD outbreak, which marked a difficult period for public health management in the region [9,11]. Tanzania's first confirmed Marburg outbreak in 2023 resulted in five deaths out of eight reported cases [21,22]. The Ministry of Health declared the first MVD outbreak in the Bukoba district of Kagera on March 21, 2023, reporting eight cases and five fatalities, including one in a healthcare worker. The case fatality ratio was 62.5%, prompting further epidemiological investigations with 205 contacts currently under observation [22]. Table 1 lists the Marburg virus disease outbreaks reported in Africa in recent decades.

ETIOLOGY OF MVD

MVD is caused by a virus classified within the Mononegavirales order, specifically within the Filovirinae family and the Marburgvirus genus. The sole strain responsible for this illness is the Marburg virus itself [1,2]. The primary reservoir of the Marburg virus is the fruit bat, Rousettus aegyptiacus, although it has also been found in monkeys and chimpanzees. Numerous outbreaks have been linked to mines, which serve as habitats for various bat species [6,7]

The transmission of the Marburg virus occurs primarily through direct contact with the bodily fluids of an infected individual, including blood, saliva, mucus, tears, vomit, semen, and feces. The virus can also spread via fomites or contaminated surfaces [23], thereby increasing the risk of

Table 1: *Marburg virus disease outbreaks in Africa*

Year	Location/Outbreak	Cases	Deaths	CFR (%)	References
1998-2000	DRC	154	128	83	(CDC, 2023)
1975	South Africa/Zimbabwe	3	1	33	(Bradfute SB, et al., 2016)
1980	Kenya	2	1	50	(Vella EE, 1977)
1987	Kenya	1	1	100	(Bradfute SB, et al., 2012)
2004-2005	Angola	374	329	88	(MoH, 2023)
2007	Uganda	4	1	25	(Changula K et al., 2014)
2012	Uganda	15	4	27	(Changula K et al., 2014)
2014	Uganda	1	1	100	(CDC, 2023)
2017	Uganda	3	3	100	(Mwananchi, 2023)
2023	Ghana	110	74	67	(WHO, 2022)
2023	Tanzania	8	5	63	(WHO, 2023)
2024	Rwanda	66	15	23	MoH (2 Dec 2024)

CFR: Case Fatality Rate

transmission to healthcare workers and family members who attend to the sick or participate in funeral rites.

Once the virus enters a person's body, it replicates within endothelial cells, prompting the release of cytokines that increase vascular permeability and lead to fluid leakage [3]. This cascade of events leads to severe symptoms such as fever, malaise, coagulopathy, and rapid onset of hemorrhagic manifestations. Additional complications, including immunosuppression, systemic inflammation, multiple organ failure, shock, and ultimately, death, may occur [10].

CONTROL OF MVD: RWANDA'S CURRENT MITIGATION EFFORTS

Following reports of an unusual illness affecting patients across seven of Rwanda's 30 districts, the Ministry of Health (MoH) issued a statement outlining the situation. In response, Rwanda is taking comprehensive measures to mitigate the MVD outbreak. It recently confirmed its first cases through the MoH and has implemented the following measures:

To minimize exposure and transmission, the government has implemented a restriction that allows only one caregiver per patient at healthcare facilities. In addition, all healthcare institutions are mandated to follow strict infection prevention and control protocols for clients exhibiting symptoms of MVD, suspected or confirmed MVD patients undergo isolation for 21 to 28 days, with all medical waste incinerated at high temperatures to prevent contamination.. To further limit gatherings that could facilitate viral spread, traditional practices such as wakes and home vigils (locally known as 'Ikiriyo') have been banned, and funeral services were restricted to a maximum of 50 attendees [12].

Furthermore, open-casket viewings are prohibited in homes, churches, and mosques. They can only occur in designated areas within health facilities, with limited attendance. The Ministry of Health has emphasized the importance of personal hygiene measures and has urged the public to avoid close contact with individuals displaying symptoms, such as high fever, severe headaches, muscle aches, vomiting, and diarrhea [12].

To trace potential cases, the Ministry has identified approximately 300 individuals who have come into contact with infected persons, and these contacts are currently under testing. The Health Minister reassured the public to remain calm and continue their daily activities while adhering to the safety measures being implemented, emphasizing that the strategies to combat the outbreak are promising [24].

Preventive measures against MVD include several key practices. Individuals should avoid contact with infected persons and maintain good hygiene. It is crucial to wear protective clothing when caring for an infected person or when working in high-risk environments. Additionally, people are advised to avoid contact with infected animals, particularly fruit bats and non-human primates. Furthermore, it is recommended to avoid or limit the consumption of bushmeat to reduce the risk of transmission.

Some institutions, including the United States Embassy, have implemented precautionary measures in response to the MVD outbreak in Rwanda. The embassy has announced that its staff members in Kigali are authorized to work remotely during this period to prioritize their safety as they assess the situation. In a statement, the embassy acknowledged the confirmed cases of MVD within health facilities in Rwanda, emphasizing that this decision is made out of an abundance of caution while the scope and severity of the outbreak are evaluated. The remote work arrangement was effective from September 30 to October 4, 2024 [12].

Risk communication and community engagement are at the heart of Rwanda's proactive response, recognizing that empowering the public with knowledge is key to containment. Public health officials are delivering targeted, culturally sensitive education on preventive behaviors, dispelling myths, and addressing concerns directly through a dedicated emergency contact line. This open line of communication fosters trust and ensures that communities feel informed and supported. In tandem, Rwanda has fortified its diagnostic and laboratory infrastructure, enabling swift and precise diagnosis within the country, significantly reducing reliance on external resources and bolstering local capacity to handle the outbreak independently [25].

To safeguard those on the front lines, Rwanda has rolled out targeted vaccination campaigns,

prioritizing healthcare workers and other high-risk individuals to create a protective shield against the virus. This proactive approach is complemented by robust cross-border collaborations, where Rwanda is working closely with neighboring countries to ensure vigilant border screening and harmonized containment efforts. These regional partnerships enhance Rwanda's defenses and prevent the virus from crossing borders, underscoring the nation's commitment to preventing a wider outbreak [25].

The vaccine in use is an experimental Marburg vaccine, developed through collaborative efforts by international health organizations, with initial research and development primarily conducted at the U.S. National Institute of Allergy and Infectious Diseases (NIAID) [26]. Early testing involved animal studies to evaluate safety and immune response, followed by limited Phase 1 trials in humans to assess safety and immunogenicity [26].

Psychosocial support for patients, survivors, and their families is also a cornerstone of Rwanda's response. By offering counseling and reintegration assistance, Rwanda aims to ease the emotional burden on those affected, fostering acceptance and reducing the stigma that often accompanies infectious diseases. Additionally, rigorous infection control and decontamination protocols are meticulously enforced, with targeted cleaning and safeguarding of affected areas. Backed by the support of global partners like WHO and Africa CDC, Rwanda's multifaceted, coordinated response demonstrates a powerful commitment to stopping the outbreak through community engagement, frontline protection, and international collaboration [25].

OUTCOMES OF INTERVENTIONS TO MITIGATE MARBURG VIRUS DISEASE (MVD) IN RWANDA

Targeted vaccination has been a cornerstone of Rwanda's MVD response, focusing initially on healthcare providers and high-risk individuals, particularly those who have had direct contact with confirmed cases. By mid-October, over 200 individuals had received vaccinations as part of an emergency vaccination campaign, which contributed to a noticeable reduction in new infections [32]. The prioritization of healthcare workers has been crucial, as they face the highest risk due to close contact with infected patients. While MVD-specific vaccines are still experimental, the administration of available investigational vaccines appears to have mitigated the spread within healthcare settings, protecting those on the frontlines [1].

Isolation and supportive treatment were implemented promptly for confirmed cases. By October 17, 43 patients had recovered from MVD, showcasing the effectiveness of early isolation and symptomatic care [33]. Rwanda's healthcare facilities were equipped to manage cases with strict infection control practices, reducing the risk of hospital-based transmission. Although there is no specific antiviral treatment for MVD, supportive care—including fluid replacement, pain management, and monitoring for complications—has been crucial in patient recovery. These efforts were bolstered by the deployment of infection control experts and personal protective equipment (PPE) to healthcare facilities [1,5].

Rwanda's contact tracing program has played a critical role in identifying, monitoring, and isolating individuals at risk of developing MVD. Enhanced contact tracing efforts enabled health authorities to identify over 800 contacts by mid-October, many of whom were isolated and monitored for symptoms [5]. Rapid identification of contacts and early intervention contributed to a decline in new cases and helped prevent further community spread.

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CHALLENGES

Healthcare Worker Infections: Despite targeted vaccinations, a considerable number of cases occurred among healthcare providers, reflecting vulnerabilities in infection control protocols. The high exposure risk faced by healthcare workers

due to close patient interactions underscores the need for continuous training and reinforcement of infection prevention measures [27].

Resource Constraints and Experimental Treatments: The lack of approved treatments or licensed vaccines for MVD meant that Rwanda had to rely on experimental vaccines and supportive care. Limited resources, including healthcare personnel and PPE, posed challenges in sustaining rigorous infection control practices over extended periods. Furthermore, the use of experimental interventions raised logistical and ethical concerns, as their efficacy is still being evaluated [28].

SUCCESS

Rapid Response and Containment: Rwanda's swift implementation of containment measures, including targeted vaccination, isolation, and rigorous contact tracing, effectively curbed the spread of MVD within a relatively short period. These actions underscored the importance of preparedness and agility in managing infectious disease outbreaks [1].

On October 6, 2024, Rwandan Health Minister Sabin Nsanzimana confirmed that the country had received approximately 700 vaccine doses from the Sabin Vaccine Institute, supported by the U.S. government and international partners. These trial vaccines were designated for high-priority groups, starting with healthcare workers, frontline response teams, and individuals who had contact with confirmed MVD cases [29]. By October 14, more than 200 individuals had been vaccinated.

To expand the vaccination effort, the Sabin Vaccine Institute dispatched an additional 1,000 investigational vaccine doses on October 31, 2024, to support a randomized clinical trial within an ongoing open-label study [30]. By the end of October, over 1,500 frontline workers had received the Sabin vaccine in Rwanda, reinforcing the country's protective measures and contributing significantly to controlling the outbreak.

All measures and strategies implemented against MVD outbreak in Rwanda successfully contained the outbreak and as of 6 December 2024, 35 days had passed without new cases, with routine survellence and follow-up of identified cases maintained (Figure 2).

Figure 2: *MVD situation in Rwanda in the first week of December 2024*

International Support and Collaboration: Partnerships with international organizations, notably the World Health Organization (WHO) and Africa CDC, provided Rwanda with essential resources and technical support. This collaboration facilitated rapid procurement of PPE, diagnostic tools, and investigational vaccines, which were critical in the initial stages of the response [5].

CALL FOR ACTION

Given the recent updates, controlling MVD was successful despite being challenging due to the limited availability of licensed treatments and vaccines, though targeted experimental vaccines have been deployed to protect high-risk individuals and healthcare workers. This makes it crucial to break the viral transmission cycle by focusing on preventing secondary transmission [31]. The WHO actively supported Rwanda in its efforts to control the Marburg virus outbreak by mobilizing resources and expertise. Dr. Matshidiso Moeti, WHO's Regional Director for Africa, emphasized the importance of quickly implementing response measures and highlighted Rwanda's strong public health system, which facilitates effective collaboration with national authorities [32]. In addition to supporting Rwanda, the WHO keeps coordinating cross-border measures with neighboring countries to ensure timely detection and control of the virus, preventing further spread.

The WHO has previously recommended adopting the One Health approach to address health threats at the animal-human–environment interface and

rapidly contain zoonotic diseases like MVD [33], and this approach was effective in reducing MVD incidence in Tanzania [21].

In the Rwandan context, addressing the MVD outbreak required a comprehensive strategy that enhances both healthcare capacity and community involvement. To effectively combat MVD, Rwanda's national healthcare budget should be increased, ensuring sufficient resources for affected regions, especially in rural and high-risk areas where healthcare infrastructure is often limited [34]. This increase would fund essential resources such as hospital beds, medical personnel, and supplies. While MVD outbreaks are uncommon, a permanent expansion of healthcare infrastructure, particularly in rural areas, is justified to improve Rwanda's preparedness for both potential outbreaks and broader health needs [34,35]. Additionally, a temporary capacity boost is necessary to manage the immediate case surge without overwhelming current facilities. Based on recent case data, experts estimate the need for 200 additional hospital beds [36], given each MVD case requires 21–28 days of isolation [48]. A permanent increase in beds and staff, despite the rarity of MVD, would bolster the healthcare system's readiness for infectious disease outbreaks and other health emergencies. This approach not only supports rapid response capability but also serves as a training and research hub, enhancing the overall resilience and capacity of Rwanda's healthcare system.

Epidemiological surveillance and community involvement are key to outbreak prevention. Coordinated monitoring programs that include both local and national stakeholders are crucial for tracking the spread of MARV. In addition, healthcare workers and researchers must be aware of the coexistence of MVD alongside other infectious diseases like mpox [37], as these can further strain Rwanda's healthcare system.
Ensuring that healthcare workers have access to adequate PPE is essential to prevent the spread of MARV. Rwanda's Ministry of Health prioritized the procurement and distribution of PPE, including gowns, gloves, masks, face shields, and goggles, especially in high-risk areas. Accurate diagnosis of MVD relies on proper laboratory testing, which should be readily available to all affected regions. Social leaders, community health workers, and healthcare professionals must be well-informed about the risk factors associated with MVD, as well as safety measures for handling animal products and conducting safe burials for those who have died from the virus. It was suggested that engaging local leaders and traditional healers in awareness campaigns can help ensure that information reaches remote and rural areas, fostering trust and compliance with safety guidelines [7,31].

Public health education efforts must emphasize avoiding contact with blood, bodily fluids, and proper hand hygiene. In cases of MARV infection, patients should be isolated in private rooms with dedicated bathroom facilities to minimize transmission. The transfer of infected patients to specialized medical facilities must be performed with strict adherence to safety protocols to prevent further spread.

Finally, the Rwandan government has to strengthen the collaboration with international organizations like the WHO, as well as local stakeholders to ensure the rapid containment of MVD outbreaks. The lessons learned from managing COVID-19 can be applied to prevent healthcare systems from becoming overwhelmed during MVD outbreaks and other future health crises. Financial and logistical support from the international community will be crucial in sustaining these efforts and reducing the likelihood of re-emerging MVD in the future.

CONCLUSION

The recent outbreak of MVD underscores the the importance of integrated surveillance systems and the impact of implementing decisive measures to curb its spread. Given the high mortality rate associated with MVD, it is crucial to recognize the significant role that healthcare providers, particularly those working in hospitals, play in the emergence and spread of outbreaks. Rwanda continious efforts to strenthen the health systems, integrating One Health principles and close collavorations with local and international health organizations will make the country stand still against future crises.

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